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ABSTRACT

This compilation of marine science institutions, academic degrees, curricula, teaching and research facilities and teaching faculties, is based on information supplied by the institutions in response to questionnaires sent by the Committee on Marine Research, Education and Facilities. Programs are categorized in five main sections: Marine Science, Ocean Engineering, Maritime Officers, Fisheries, and Marine Technician. In the first section, only programs involving fifteen semester hours or more are included; institutions offering shorter courses are listed in an appendix. (EB)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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UNIVERSITY CURRICULA
IN THE
[illegible] AND RELATED FIELDS

ED041745

ACADEMIC YEARS
1969-70 AND 1970-71

NATIONAL COUNCIL ON MARINE RESOURCES
AND ENGINEERING DEVELOPMENT

SE 009 053

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UNIVERSITY CURRICULA
in the
MARINE SCIENCES AND RELATED FIELDS

ACADEMIC YEARS
1969-70 and 1970-71

Prepared by:
MARINE SCIENCES AFFAIRS STAFF
of the
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FOREWORD

In recent years, the Federal Government has assumed a major responsibility for the support of training and education of scientists, engineers, and technicians. This policy has significantly strengthened the marine sciences.

A principal function of the National Council on Marine Resources and Engineering Development is to coordinate Federal efforts in meeting long-range national goals in the marine sciences. Skilled manpower, in terms of both numbers and quality, is central to advancement in the marine sciences and achievement of these goals, for it is the individual talents which pace our progress.

This booklet provides information about training programs in the marine sciences and related fields. A wide diversity of curricula and several possible levels of training are described. Career opportunities in the marine field and the pathways to these careers are also indicated. The booklet is intended to aid in fostering full use of existing training facilities for students seeking marine science careers.

The Council is grateful for the cooperation of the many administrators and faculty members of the institutions who supplied the information for this Report. In particular, the counsel and advice of the National Academy of Sciences Committee on Oceanography and the National Academy of Engineering Committee on Ocean Engineering are gratefully acknowledged.

Edward Wenk, Jr.

Edward Wenk, Jr.
Executive Secretary
National Council on Marine Resources
and Engineering Development

INTRODUCTION

This compilation of marine sciences institutions, academic degrees, curricula, teaching and research facilities and teaching faculties is based on information supplied by the institutions in response to questionnaires sent by the Committee on Marine Research, Education and Facilities. Only those institutions which responded to the questionnaire are included.

In the title of this document the term "marine sciences" refers to academic programs in oceanography, marine science and ocean engineering; these program areas place significant emphasis on the oceans. The distinction between "oceanography" and "marine science" reflects terms used by the institutions themselves. Generally, "oceanography" is considered a multi-disciplinary science whereas "marine science" refers to the marine branch of a particular scientific discipline—i.e., geology, chemistry, biology, etc. The titular term "related fields" refers to academic programs for training ships' officers and maritime engineers, naval architects, marine (science and engineering) technicians, and applied fisheries scientists and technicians.

The omission in this report of degrees in fields other than marine sciences does not in any way imply that a system of training which culminates in a marine sciences degree is superior to that which channels training through the more traditional scientific or engineering disciplines. Students with a primary interest in a classical discipline may wish to investigate its possibilities in relation to ocean-oriented work.

This booklet is not intended to provide a detailed description of each academic program nor is it to be considered a compilation of official college catalogs. **Prospective students are strongly urged to obtain further information directly from those institutions in which they are interested.**

Programs of the institutions which responded to the questionnaire have been placed in one or more of the five major sections of this report: Marine Science; Ocean Engineering; Maritime Officers; Fisheries; or Marine Technician. Institutions included in the marine science category offer at least fifteen semester hours or equivalent of primarily ocean-oriented courses. Those which offer less than fifteen semester hours are listed in Appendix A. Some 57 institutions have joined forces into four regional consortia, i.e., four partnerships which jointly support and use a common shore laboratory for research and educational purposes. These consortia programs are separately noted. All of the institutions which reported offering ocean engineering programs are included, as are those offering marine-related training programs in or for maritime operations, technicians and fisheries science and technology.

A standardized format has been followed in describing all of the programs. Institutions are listed alphabetically in each of the five program areas. Each institutional program is described in terms of its teaching and research facilities—laboratories, classrooms, ships, computers, etc.—and its academic programs and staff. Degrees offered and degree requirements of the institutions are described. Academic courses are listed by department name, course number and title, terms in which given and credits per course; departments and course descriptions are as used by the institution. Semesters in which the courses are offered are coded as: F-Fall, Sp-Spring, Su-Summer; W-Winter is used for those having a quarterly system. Credit hours are in accord with each institution's system, either semester or trimester/quarter. Three trimester hours equal two semester hours. Faculty are listed by department with the reported name of Chairman first. Each faculty member is listed with his rank reported at the time this pamphlet was prepared and with his or her highest academic degree earned. The name and address of the person to whom to direct inquiries is noted lastly for each institution.

TYPICAL REQUIREMENTS FOR ADMISSION TO GRADUATE STUDY

The formal requirements for admission to graduate study in marine science and ocean engineering vary greatly from one institution to another. However, basic minimum requirements can be identified as common prerequisites to admission.

Oceanography and Marine Science: The general requirements for admission to graduate schools are as follows:

(1) A baccalaureate degree from an accredited college or university with a major in biology, chemistry, engineering, geology, mathematics, oceanography, or physics.
(2) A cumulative undergraduate grade average of approximately "B" (or 3.00 on a 4.00 scale).
(3) Mathematics through differential and integral calculus.
(4) One year of chemistry, with laboratory.
(5) One year of physics, with laboratory.
(6) One semester of geology, with laboratory.
(7) One semester of biology, with laboratory.
(8) A broad background in the humanities.

It should be noted that these minimum requirements may be modified or waived for admission to a specific program. Students whose backgrounds do not include all of the required courses may in some cases be permitted to complete prerequisite courses, whether prior to or after admission to graduate study.

Satisfactory completion of additional courses such as the following is regarded as highly desirable for admission to study in particular disciplines: advanced calculus, differential equations, thermodynamics, organic chemistry, historical and structural geology, and vertebrate and invertebrate zoology. For admission to a specific discipline within the marine sciences the student should have an undergraduate major in the same or a closely related discipline, with appropriate minors. For instance, for admission to study in physical oceanography a student should have had a major in physics and a minor in mathematics or vice-versa.

Ocean Engineering: For students applying to graduate ocean engineering programs, requirements are not as clearly specified as those for the marine sciences. Broad general requirements can be identified as:

(1) A baccalaureate degree in engineering or science from an accredited college or university.
(2) A cumulative undergraduate grade average of approximately "B" (or 3.00 on a 4.00 scale).
(3) Mathematics through differential equations.

Satisfactory completion of additional courses in mathematics, especially in advanced calculus, probability, and statistics, physical and life sciences, and economics is highly desirable.

Other requirements commonly include the taking of the Graduate Record Examinations and submission of recommendations from major professors. Deadlines for submission of applications and the schedules for fees vary greatly from institution to institution.

FINANCIAL ASSISTANCE PROGRAMS
AVAILABLE FOR COLLEGE STUDENTS

Programs of Department of Health, Education and Welfare

National Defense Student Loan Program. Under this program students at all levels–from high school graduate to Ph.D. candidates–may be eligible for long-term, low-interest loans.

High school graduates who have been accepted for enrollment by participating colleges and universities, as well as graduate and professional students who are enrolled at least half time, and who need financial assistance are eligible for student loans.

An eligible undergraduate may borrow up to $1,000 each academic year–to a total of $5,000. An eligible graduate or professional student may borrow as much as $2,500 each year to a maximum of $10,000. Repayment need not begin until nine months after the student leaves college. Interest on the loan is three percent per year. Up to fifty percent of the loan may be cancelled or "forgiven" at the rate of ten percent for each year the borrower teaches in a public or other nonprofit elementary or secondary school or in an institution of higher education in the United States. The total loan may be cancelled at fifteen percent per year for teaching in certain schools in low-income areas.

College Work–Study Program. This program, supported by the Office of Education and administered by the participating colleges, provides students with an opportunity to earn part of their college expenses by working within the college or university or for a public or private non-profit organization. While classes are in session, a student may not work more than fifteen hours a week. During vacation periods, a student may work forty hours a week.

Guaranteed Loan Program. Students in attendance or accepted for admission in accredited institutions are eligible to borrow for college or vocational training expenses under this program. In general, depending upon the state in which they live, students may borrow up to $1,500 per year. For students whose adjusted family income is less than $15,000 a year, the Federal government will pay all interest charges (up to a maximum of seven percent) during the time they are in school and before the repayment period begins some nine to twelve months after studies are terminated.

Educational Opportunity Grants Program. This program, authorized by the Higher Education Act of 1965, provides for grants ranging from $200 to $1,000 to students of exceptional financial need for each of the four years of undergraduate study. Colleges participating in the program determine the student recipients of the grants and the amount required by the student. Any student in extreme financial need who has been accepted for admission at a participating college or who is already enrolled and in good standing is eligible to apply for a grant.

For further information on these four programs, write to the U.S. Office of Education, Division of Student Financial Assistance, Washington, D. C. 20202.

Programs of the Veterans Administration

Junior GI Bill. Under provisions of the Junior GI Bill and its recent amendments, educational allowances are paid to children (generally between the ages of 18-26) of veterans who were permanently or totally disabled, who died as a result of service in the U.S. Armed Forces, or who had peacetime service after the Spanish American War and prior to September 14, 1940.

Veterans Readjustment Benefits Act of 1966. This Act provides educational opportunities for qualified servicemen or women who have served in the Armed Forces on active duty for more than 180 days any part of which occurred after January 31, 1955, and for servicemen or women currently on active duty. Eligibility ceases at the end of 8 years after the date of the veterans' last release from active duty and assistance is available for a maximum of 36 months. Monthly payments vary with the type of training being sought and the number of dependents.

For further information on these two programs, write to any organization for veterans or your nearest Veterans Administration Office.

Reserve Officer Training Programs (ROTC). The Army, Navy, and Air Force conduct reserve officer training programs at selected colleges and universities. Financial assistance grants are available to selected students. After completion of one of these programs, the student agrees to serve a stipulated period of time in the military service. Inquiries should be directed to the Chairman of the Department of Military Science of the institution in which the student plans to enroll or to the Department of Defense, Washington, D. C. 20301.

Other Federal Scholarship or Grant Awards. Some federal agencies provide financial support to students, both directly and indirectly. One such program is that of the Maritime Administration of the Department of Commerce which provides state maritime academies with $600 per year for each student enrolled. This money is deposited in the student's account at the academy to be used for books, uniforms, etc.

In addition, Federal agencies support marine research programs at many universities. These programs provide financial support for graduate students in the form of assistantships, research fellowships, grants, and teaching stipends. Applications for such financial support should be made to the institution.

State Programs. A majority of the states and Puerto Rico sponsor financial assistance programs for undergraduate and first professional degree students. The amount and form of assistance as well as eligibility requirements vary among the states. The amount of aid often depends upon such factors as family income and other assets. To be eligible for assistance, students may be required to pass examinations, have superior academic records, or be enrolled in specific fields. Forms of assistance include loans, scholarships and grants-in-aid. Further information on State sponsored programs may be obtained from high school counselors and State departments of education. Some specific sources of financial assistance are noted in the **Need A Lift** publication listed below.

Nongovernmental Scholarships and Loans. Financial assistance programs maintained by local, state, and national units of social, civic, religious, and fraternal organizations provide loans and scholarships to outstanding and worthy students. In addition, many national scholarships are awarded through specific colleges to qualified students by large corporations and foundations.

The following publications provide information on other available assistance programs and may be obtained from the indicated offices.

"Federal Benefits for Veterans and Dependents" (VA Fact Sheet 1S-1)–Free of Charge
Veterans Benefits Office
Veterans Administration
Washington, D. C. 20420

"More Education, More Opportunity"–Free of Charge
U. S. Office of Education
Division of Student Financial Aid
Washington, D. C. 20202

"Need A Lift"–$.25 per copy (pre-paid)
American Legion, Department S
P. O. Box 1055
Indianapolis, Indiana 46206

"Opportunities in Oceanography"–$1.00 per copy
Smithsonian Press
Smithsonian Institution
Washington, D. C. 20560

"Scholarships for American Indian Youth"–Free of Charge
Bureau of Indian Affairs
Department of the Interior
Washington, D. C. 20240

"Financing a College Science Education"
Single copies may be obtained free of charge from the National Science Foundation, Washington, D. C. 20550
Copies may be purchased in the quantity from the U. S. Government Printing Office, Washington, D. C. 20402–$.15 per copy.

CURRICULA IN THE MARINE SCIENCES

UNIVERSITY OF ALASKA
College, Alaska

On the main University of Alaska campus at College, the Institute of Marine Science is currently housed within the Duckering Building. The Institute library employs a full-time librarian and contains over 5,000 volumes, together with a large reprint file relating principally to oceanography and ocean engineering. This latter collection is coded and computerized for rapid retrieval of specific information. In addition to this facility, the main University library and the specialized collections of other campus institutes and departments are readily available. The Institute also maintains an upgraded drafting and photographic unit.

The chemical oceanography section now has two specialized gas chromatographs for determining hydrocarbon pollutants in seawater. Within the same section, new equipment for work on trace inorganics in both freshwater and seawater has required the addition of specialized polarographic modules, and relocation has made it possible for both the biology-ecology and geology sections to acquire new equipment. In addition to the stable isotope analysis equipment, facilities are now available for gas, pigment, nutrient, carbon, nitrogen, and elemental tracer analyses in the biological laboratories. The marine geology laboratory is equipped with standard size analysis apparatus, petrographic microscopes, atomic absorption spectrophotometer, and a pressure flow system for diagenetic experiments.

The Douglas Marine Station, located near Juneau, now consists of two buildings with facilities for research, instructing, administration, equipment fabrication, and storage. A total of 10,000 sq. ft. of floor space includes laboratories for biology, chemistry, geochemistry, petrology, and sedimentology, with two general-purpose labs and a lecture room for summer field courses. Additional facilities available include a small library, darkroom, rock preparation lab, and a small walk-in cold storage unit for deep-sea sediment cores. Major research equipment recently added to the Marine Station includes a Perkin-Elmer 303 atomic absorption spectrophotometer and a Ziess Ultraphot microscope.

The station's Mt. Jumbo Building serves as a 20-man dormitory and also houses a machine shop, a plastics fabrication bench, and a wood-working shop. One of the principal missions of the Douglas Marine Station is the support of both the R/V ACONA and M/V MAYBESO.

In cooperation with the U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, the Institute of Marine Science has constructed a field station on the shore of Izembek Lagoon, an embayment of the Bering Sea 15 miles from the village of Cold Bay. The station, consisting of two quonset huts originally built during the military occupation of the area 25 years ago, comprises living quarters and a laboratory. These facilities can accommodate 3 or 4 investigators plus technicians. The equipment includes the essentials for routine chemical and biological work plus some specialized instruments for physiological studies.

For work in the Arctic Ocean and on the northern coast of Alaska, facilities are made available to the Institute by the Naval Arctic Research Laboratory at Point Barrow. The NARL provides all logistic support (including rig transportation) for work on the north coast and on the T-3 Ice Island. The Institute shares two hydro-huts with the physical oceanography group from the University of Washington.

The Institute operates the Research Vessel ACONA as its principal oceanographic platform. The R/V ACONA is an 80-foot steel vessel which carries a professional crew of six and a scientific party of nine. The ACONA is equipped with an oceanographic winch, a light hydrographic winch, two radars, three depth sounders, a precision depth recorder, three radio transceivers, loran, and other standard navigational equipment. The laboratory space requires most scientific equipment to be temporarily installed and removed each cruise. The ACONA has a speed of nine knots and an endurance of three weeks or 4500 miles.

The Institute also operates the 42-foot Motor Vessel MAYBESO—an eight-knot, wooden craft of basic fishing vessel design. The MAYBESO has a professional Captain and carries a four-man scientific party. The ship is equipped with a 400-meter hydrographic winch, two radio transceivers, and two depth sounders. Two 16-foot Boston Whalers and several miscellaneous skiffs are maintained at Douglas for daily use in the local area. Other vessels and aircraft are, on occasion, chartered for specific work required by Institute programs.

The purpose of the program in oceanography is to train oceanographers at the M.S. and Ph.D. level. The program is coordinated by an interdisciplinary committee of the University composed of selected staff members from the academic colleges and research institutes involved with ocean science.

The following degrees are offered in oceanography:

1. **M.S. Degree in Biological Oceanography.** (Thesis required)
Prerequisites–B.S. in the natural sciences, courses in calculus and physical chemistry.
Minimum credit requirements–30 graduate credits (9 of which may be thesis credits). Course requirements–OCN 620, OCN 661, and OCN 613 or Biol. 652, and a minimum of six credits of additional course work to be selected by the student's committee.
2. **M.S. Degree in Chemical Oceanography.** (Thesis required)
Prerequisites–B.S. in the natural sciences, courses in calculus and physical chemistry.
Minimum credit requirements–30 graduate credits (9 of which may be thesis). Course requirements–OCN 620, OCN 663, OCN 650, or OCN 613, and a minimum of 6 credits of additional course work to be selected by the student's committee.
3. **M.S. Degree in Geological Oceanography.** (Thesis required)
Prerequisites–B.S. in the natural sciences, courses in calculus and physical chemistry.
Minimum credit requirements–30 graduate credits (9 of which may be thesis credits). Course requirements–OCN 620, OCN 661 and OCN 650 or Biol. 652, and a minimum of 6 credits of additional course work to be selected by the student's committee.
4. **M.S. Degree in Physical Oceanography.** (Thesis required)
Prerequisites–B.S. in the natural sciences, courses in calculus and physical chemistry.
Minimum credit requirements–30 graduate credits (9 of which may be thesis credits). Course requirements–OCN 620, OCN 661, and OCN 650 or OCN 613, and a minimum of 6 credits of additional course work to be selected by the student's committee.
5. **Ph.D. Degree.** There are no fixed course requirements nor is an M.S. degree required to obtain the Ph.D. degree. The degree is awarded for proven ability and scholarly attainment, the exact program to be determined by the student's advisory committee. A candidate for the Ph.D. degree in Marine Science will be expected to have had course work at least equivalent to that of the M.S. curriculum. Reading ability in one foreign language, appropriate to the student's discipline, is required.

The following courses are offered in conjunction with the above degrees:

OCN 613	Marine Geology	Sp	3
OCN 620	Introduction to Physical Oceanography		
OCN 622	Ocean Currents and Water Masses		3
OCN 630	Estuarine Dynamics		
OCN 650	Introduction to Biological Oceanography		3
OCN 661	Chemical Oceanography I		3
OCN 663	Chemical Oceanography II		3
OCN 690	Colloquium		3
OCN 691–692	Seminar		3
OCN 693–694	Special Topics		3
OCN 697–698	Thesis		3
Biology			
Biol. 652	Marine Ecology		3
Chemistry			
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Geology			
Geol. 401	Invertebrate Paleontology	F	4
Geol. 631	Marine Geochemistry	F	3
Physics			
Phys. 361	General Geophysics	F	3
Phys. 362	General Geophysics	Sp	3
Phys. 460	Geophysical Prospecting	F	3

Physics—*Continued*			
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Phys. 621	Classical Mechanics	F	3
Phys. 625	Hydrodynamics	F	3
Phys. 665	Dynamic Meteorology	F, Sp	3, 3
Wildlife Management			
W.M. 325	Scientific Sampling	F	3
W.M. 423	Limnology	F	3
W.M. 424	Ecology of Fishes	Sp	3
W.M. 426	The Analysis of Linearized Models	Sp	3
W.M. 624	Problems in Fisheries Management	Sp	2

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Hood, Donald W., Ph.D., Director, Institute of Marine Science and Professor of Marine Science; Chemical Oceanography
Allen, Mary Belle, Ph.D., Professor of Microbiology and Marine Algology
Barsdate, Robert J., Ph.D., Associate Professor; Limnology and Chemical Oceanography
Behlke, Charles E., Ph.D., Dean of College of Mathematics, Physical Sciences and Engineering; Professor of Engineering
Benson, Carl S., Ph.D., Associate Professor of Geology and Geophysics
Berg, Eduard, Ph.D., Professor of Geophysics
Billaud, Vera A., Ph.D., Assistant Professor of Marine Science; Limnology
Burrell, David C., Ph.D., Assistant Professor of Marine Science; Geochemistry
Button, Don K., Ph.D., Associate Professor of Marine Science; Biochemistry
Forbes, Robert E., Ph.D., Chairman and Professor of Geology; Igneous Petrology
Goebel, Davis, Jr., Ph.D., Associate Professor of Electrical Engineering; Arctic Environmental Engineering Laborarory
Goering, John J., Ph.D., Professor of Marine Science; Biological Oceanography
Hoskin, Charles M., Ph.D., Assistant Professor of Geology; Sedimentology
Irving, Laurence, Ph.D., Advisory Scientific Director and Professor of Zoophysiology; Institute of Arctic Biology
Kinney, Patrick, J., Ph.D., Assistant Professor of Marine Science; Chemical Engineering
Matthews, J. Brian, Ph.D., Assistant Professor of Marine Science; Physical Oceanography
Mcroy, Peter C., M.S., Senior Research Assistant; Biological Oceanography
Miller, Keith L., Ph.D., Assistant Professor of Zoophysiology
Morrow, James E., Ph.D., Head, Department of Biological Science; Professor of Zoology
Natarajan, Kottayam V., Ph.D., Assistant Professor; Marine Microbiology
Nayudu, Y. R., Ph.D., Associate Professor of Marine Science; Geological Oceanography
Osterkamp, Thomas E., Ph.D., Assistant Professor of Physics
Peyton, Harold R., Ph.D., Professor of Engineering; Arctic Environmental Engineering Laboratory
Reeburgh, William S., Ph.D., Assistant Professor; Chemical Oceanography
Roberts, Thomas D., Ph.D., Associate Professor of Physics
Rosenberg, Donald H., M.S., Assistant Professor; Physical Oceanography
Sharma, Ghanshyam D., Ph.D., Assistant Professor; Marine Geology
Stone, David B., Ph.D., Research Associate Professor of Geophysics, Geophysical Institute
Van Hyning, Jack M., M.S., Associate Professor of Fisheries Biology
Wright, Frederick F., Ph.D., Assistant Professor; Marine Geology

To obtain further information, address all inquiries directly to:

Dr. Donald W. Hood, Director
Institute of Marine Science
University of Alaska
College, Alaska

ALFRED UNIVERSITY
Alfred, New York

The University offers marine and related science courses within the context of a program in Environmental Studies. The Geology, Chemistry, Physics, and Biology Departments are housed in modern buildings with adequate facilities for laboratory instruction and research. Faculty and students may also use the technical services and facilities of the College of Ceramics, a unit of the State University of New York and an integral part of Alfred University. The facilities, housed in Binns-Merrill Hall, include special laboratories for chemistry, petrography, spectroscopy, electron microscopy, X-rays, and mass spectrometry. A Computer Center equipped with an IBM 1800 real-time computer is also available for instruction and research.

Field programs are conducted on nearby Seneca Lake which has a maximum depth of over 600′ and is ice-free throughout the year. The University charters the LAKE DIVER IV, a 44-ton former Coast Guard buoy tender. The vessel has an adequate power source, winches for handling heavy equipment, a fathometer, and ship-to-shore communication facilities. A radar unit will be added in the near future. Scientific equipment includes: dredges, corers, plankton collecting devices, a television camera, Nansen bottles, temperature recording apparatus, and an on-board wet-chemical analytical laboratory.

The University offers the B.A. degree through its College of Liberal Arts. The Program represents an undergraduate interdisciplinary approach to regional problems of the human community and is designed to give students an opportunity to participate in the application of basic knowledge to problems of man and his environment.

In addition to the standard requirements for a science or social science major, the Program requires course work in Sociology, Physical Geography, Aquatic Science and Ecology. The selection of electives appropriate to the development of an independent research project to be completed in the senior year is also encouraged. A required senior interdepartmental seminar considers topics of broad interest to the area of environmental study and provides an opportunity for the exchange of ideas between students and faculty working on specific problems. The student who completes the Environmental Studies Program will receive certification on his academic record.

The following courses are offered in conjunction with the above program:

Department of Biology			
350	Limnological Methods	F	3
394	Ecology	Sp	4
491–492	Seminar (Interdepartmental)	F, Sp	1, 1
550	Research (Limited to Seniors and Graduate Students) credit hours to be arranged	F, Sp	
Department of Chemistry			
211	Inorganic Chemistry of Aqueous Solutions	F	4
450 or 550	Independent Study credit hours to be arranged	F, Sp	
Department of Geology			
327	Physical Geography	F	3
332	Oceanography	Sp	3
450	Independent Research (Limited to Seniors)	F, Sp	1–3

The instructional staff for the courses listed above consists of the following:

Department of Geology

Sass, Daniel B., Ph.D., Chairman and Professor of Geology

Department of Biology

Finlay, Peter S., Ph.D., Chairman and Professor of Biology
Rough, Gaylord E., Ph.D., Professor of Biology
Barton, J. D., Jr., Ph.D., Professor of Biology
Gerace, Donald T., M.S., Lecturer in Science Education

Department of Chemistry

Sands, Richard D., Ph.D., Associate Professor of Chemistry

To obtain further information, address all inquiries directly to:

Dr. J. D. Barton, Jr.
Provost and Vice President for Academic Affairs
Alfred University
P. O. Box 1285
Alfred, New York 14802

THE UNIVERSITY OF ARIZONA
Tucson, Arizona

An international cooperative marine sciences program between the University of Arizona and the Universidad de Sonora in Hermosillo was initiated in 1958; and programs in field research and training have expanded since that time. The present Marine Sciences program and facilities are located in the Biological Sciences Building on the Campus in Tucson and extensive new quarters are currently under construction. The Puerto Peñasco Marine Research Station is located one and one-half miles southeast of the small fishing port of Puerto Peñasco, Sonora, Mexico. The Station was built on 49 acres of land facing on the Gulf of California. It is located 225 road miles southwest of Tucson, about an hour by air from either Tucson or Hermosillo. The 750 sq. ft. Laboratory has one large room equipped with two chemical benches and shelving, and an office, library and storeroom. Shielded sea water tables and sorting areas are on three sides of the Laboratory. These are fed by a salt water system drawing naturally filtered sea water from a nearby beach well. Plans call for converting a second building into a research laboratory. Within a short distance of the Station, there is a great diversity of marine ecological environments. The municipal port area has deep water docking facilities. A 23-foot LONE STAR cabin cruiser, with trailer, is assigned to the Station. It is equipped with wet and dry specimen laboratory facilities and the basic collecting gear.

The following degrees are offered in the indicated basic sciences:

1. **Ph.D. in Biology, Botany or Zoology, Department of Biological Sciences.** Students majoring in Marine Biology in the department may elect to take the doctorate degree in either Biology, Botany or Zoology. In addition to the major, a suitable minor area must be selected. An approved dissertation problem in the marine sciences is required. In addition to an individually planned graduate study program, the student must (1) obtain proficiency in elementary statistics applied to data from biological systems, and (2) demonstrate proficiency in two foreign languages or high proficiency in one, or demonstrate proficiency in one foreign language and complete an approved formal course in statistics or computer techniques.

2. **M.S. in Biology, Botany or Zoology, Department of Biological Sciences.** Students majoring in Marine Biology in the department may elect to take the master's degree in either Biology, Botany or Zoology. An approved thesis problem in the marine sciences is required. The student must satisfactorily complete 30 graduate credit units in an approved graduate study program.

Courses in the marine sciences are offered during the regular year at the main campus by the Departments of Biological Sciences and Hydrology and Water Resources. The Department of Biological Sciences also offers both regular summer courses and special field research instruction at the Puerto Peñasco Marine Research Station.

Department of Biological Sciences:			
240	Oceanography	Sp	2
240L	Oceanography Laboratory	Sp	2
242	Marine Ecology	Su	5
243	Marine Invertebrate Zoology	Su	5
266	Comparative Physiology	F	4
275	Phycology	F	4
276	Marine Algae	Sp	3
280	Invertebrate Zoology	Sp	4
282	Ichthyology	Sp	4
340	Advanced Studies in Marine Biology	F or Sp	2
399	Seminar	F, Sp	1–3
400	Research	F, Sp	1–8
410	Thesis	F, Sp	1–8
420	Dissertation	F, Sp	1–9
Department of Hydrology and Water Resources:			
281	Physical Oceanology and Limnology for Hydrologists	Sp	2

The instructional staff for the courses listed above consists of the following:

Atmospheric Physics Institute
- Sellers, William D., Ph.D., Professor of Meteorology

Department of Biological Sciences
- Baldwin, Howard A., M.S., Research Associate in Biological Sciences
- Carlson, John S., Ph.D., Assistant Professor of Biological Sciences
- Hoshaw, Robert W., Ph.D., Professor of Biological Sciences
- Mead, Albert R., Ph.D., Professor of Biological Sciences
- Pickens, Peter E., Ph.D., Associate Professor of Biological Sciences
- Russell, Stephen M., Ph.D., Associate Professor of Biological Sciences
- Thomson, Donald A., Ph.D., Associate Professor of Biological Sciences

Environmental Research Laboratory
- Hodges, Carl N., B.S., Supervisor of the Environmental Research Laboratory

Department of Geology
- Schreiber, Joseph F., Ph.D., Professor of Geology

Department of Hydrology and Water Resources
- Simpson, Eugene S., Ph.D., Professor of Hydrology and Water Resources

Department of Nuclear Engineering
- Post, Roy G., Ph.D., Professor of Nuclear Engineering

Department of Systems Engineering
- Browning, Gen. Samuel R., M.S., Professor of Systems Engineering

To obtain further information, address all inquiries directly to:

Dr. Albert R. Mead
Chairman, Marine Sciences Committee
University of Arizona
Tucson, Arizona 85721

BODEGA MARINE LABORATORY
(UNIVERSITY OF CALIFORNIA)
Bodega Bay, California

The Bodega Marine Laboratory is a research and teaching facility of the University of California. The Laboratory is situated on a 326-acre biological refuge located on the outer coast of Bodega Head; the property includes more than a mile of rocky shoreline, short stretches of sandy beach, and mixed mud and sand flats in Bodega Harbor. The laboratory building houses 25 modern research laboratories and 2 teaching laboratories. Equipment and facilities are available for work in biochemistry, physiology, developmental biology, microbiology, ecology, botany, zoology, and marine geology. The laboratory is provided with running sea water which is pumped directly from the ocean; there is a large aquarium room which contains numerous aquaria and tanks which range in size up to a capacity of 1000 gallons. A 31-foot diesel powered cruiser and a 22-foot bartender are available for work in the open sea; other, smaller, boats are available for work in the harbor.

The degrees of **Master of Arts and Doctor of Philosophy in Botany and in Zoology** are offered by the Botany and Zoology Departments on the Berkeley and Davis Campuses for research carried out at the Bodega Marine Laboratory. Courses at the Laboratory are credited toward degree work on these and other campuses of the University of California.

The following courses are offered in 1969 in conjunction with the above programs:

Courses taught at BML are offered under the aegis of departments located on campuses of the University.

UNDERGRADUATE

Botany Department, Berkeley Campus

104	Marine Botany

Geology Department, Davis Campus

S119	Marine Geology and Paleoecology of the Continental Shelf
198	Directed Group Study
199	Special Study for Advanced Undergraduates

Zoology Department, Berkeley Campus

157	Biology of Marine Invertebrates

GRADUATE

Geology Department, Davis Campus

S219	Special Studies in Marine Geology and Paleoecology
298	Group Study
299	Research

Zoology Department, Berkeley Campus

257	Advanced Biology of Marine Invertebrates

The instructional staff (1968) for the courses listed above consists of the following:

Ghiselin, Michael T., Ph.D., Assistant Professor of Zoology, University of California, Berkeley
Holland, Nicholas C., Ph.D., Assistant Professor of Marine Biology, University of California, San Diego
Lipps, Jere H., Ph.D., Assistant Professor of Geology, University of California, Davis
Stasek, Charles R., Ph.D., Associate Professor of Zoology, Florida State University
Todd, Thomas W., Ph.D., Assistant Professor of Geology, University of California, Davis
West, John A., Ph.D., Assistant Professor of Botany, University of California, Berkeley
Valentine, James W., Ph.D., Associate Professor of Geology, University of California, Davis

To obtain further information, address all inquiries directly to:

Dr. Cadet Hand, Director
Bodega Marine Laboratory
P. O. Box 247
Bodega Bay, California 94923

UNIVERSITY OF CALIFORNIA, DAVIS
Davis, California

The marine sciences program on the Davis campus provides instruction and research opportunities in geological and biological oceanography. This program is offered in the Departments of Geology and Zoology, and the Institute of Ecology. Each of these instructional units provides modern well-equipped laboratory, instrumental, and shop facilities, including transmission and scanning electron microscopes, an electron microprobe, controlled environment rooms, sea water systems, etc. The Zoology Department and Institute of Ecology have recently moved into new buildings, and the Geology Department will move into a new building in 1970.

In addition to the facilities on the Davis campus, the marine sciences program is supported by the Bodega Marine Laboratory, Bodega Bay, California, which is described earlier in this section.

The following degrees are offered in the basic sciences:

1. Department of Geology: **B.A., B.S., M.S., Ph.D. in Geology with specialization in marine science.**
2. Department of Zoology: **B.A., B.S., M.A., Ph.D. in Zoology.**
3. Ecology Graduate Group: **M.S., Ph.D. in Ecology with specialization in marine science.**

The Departments of Geology and Zoology, and the Institute of Ecology offer advanced degrees with thesis research in marine geology, ecology, paleoecology, or sedimentary petrology. An integrated, full-time program will be offered during the regular school year by the Departments of Geology and Zoology. A special curriculum in "Animal evolution in marine ecosystems" will be provided for advanced undergraduates and graduates by the Geology and Zoology Departments during the spring quarters.

The following courses are offered in conjunction with the above programs:

Ecology		
201A		
201B		
201C		
Geology		
105	Structural Geology	4
107	Paleobiology	5
111A	Paleobiology of Invertebrata	4
111B	Paleobiology of Protista	4
S119	Marine Geology and Paleobiology	9
126	Sedimentation	4
153	Studies in Geomorphology	3
190	Seminar in Geology	1
198	Directed Group Study	1–5
199	Special Study for Advanced Undergraduates	1–4
213	Geomorphology	3
216	Tectonics	3
S219	Research in Marine Geology & Paleobiology	6–9
257	Sedimentary Petrology: Terrigenous Rocks	4
258	Sedimentary Petrology: Carbonate Rocks	4
260	Paleontology	3
261	Paleocoenology	3
262	Paleosystematics	3
263	Functional Morphology of Fossil Invertebrates	4
290	Seminar in Geology	1
298	Group Study	2
299	Research	1–6

Zoology

112	Invertebrate Zoology	5
114	Invertebrate Physiological Ecology	5
116	Principles of Animal Resource Management	5
125	Animal Ecology	3
125L	Field Ecology	3
140	Limnology	4
140L	Limnology Laboratory	3
142	Invertebrate Physiology	4
142L	Invertebrate Physiology Laboratory	3
144	Oceanography	4
147	Zoogeography	4
148	Animal Phylogeny and Evolution	5
160	Invertebrate Neurophysiology	5
197	Senior Colloquium in Zoology	2
199	Special Study for Advance Undergraduates	1–5
202	Biomathematics	6
222	Mathematical Models of Ecosystems	4
223	Seminar in Fisheries Management	4
293	Seminar in Invertebrate Zoology	2
294	Seminar in Animal Ecology	3
295	Seminar in Limnology	3
297	Seminar in Systematic Zoology & Evolution	2
298	Group Study	1–5
299	Research	1–9

The instructional staff for the courses listed above consists of the following:

Department of Geology

Chipping, David H., M.S., Lecturer of Geology
Cowen, Richard, Ph.D., Assistant Professor of Geology
Higgins, Charles G., Ph.D., Professor of Geology
Lipps, Jere H., Ph.D., Assistant Professor of Geology
Moores, Eldridge M., Ph.D., Assistant Professor of Geology
Valentine, James W., Ph.D., Professor of Geology

Department of Zoology

Goldman, Charles R., Ph.D., Professor of Zoology
Hamner, William M., III, Ph.D., Assistant Professor of Zoology
Kammer, Ann E., Ph.D., Assistant Professor of Zoology
Miller, Milton A., Ph.D., Professor of Zoology
Rudd, Robert L., Ph.D., Associate Professor of Zoology
Salt, George W., Ph.D., Associate Professor of Zoology
Watt, Kenneth E. F., Ph.D., Professor of Zoology

To obtain further information, address all inquiries directly to:

Geology and Ecology: Dr. Jere H. Lipps
Department of Geology
University of California
Davis, California 95616

Zoology: Graduate Advisor
Department of Zoology
University of California
Davis, California 95616

THE UNIVERSITY OF CHICAGO
Chicago, Illinois

The Marine Sciences Program at the University of Chicago is within the Department of the Geophysical Sciences, located in the Henry Hinds Laboratory for the Geophysical Sciences. The central core of the building consists almost entirely of research laboratories and associated shop facilities. Among these are several wave tank laboratories which include wave tanks up to eighty feet long used for beach studies, random wave and interaction studies, and internal wave investigations. Other facilities include a flume, wind tunnel, paleoecology laboratory, sedimentology laboratory, geochemistry laboratories, an electron microprobe, and x-ray diffraction equipment. The Hydrodynamics Laboratory occupies the sub-basement. The University Computing Center is close by. Field facilities are available through cooperation with the Woods Hole Oceanographic Institution and the Pacific Marine Station of the University of the Pacific.

Degrees are not offered specifically in the Marine Sciences or Oceanography. The M.S. and Ph.D. degrees in the Geophysical Sciences are offered with specialization in the areas included within the Marine Sciences.

1. **Master of Science (Geophysical Sciences).** The requirements for this degree are:

a. A program of study approved by the Departmental Counsellor, normally consisting of nine graduate courses: at least three basic-science courses, at least three geophysical science courses, and at least one research course. Courses in basic-science may be taken in or outside the department.

b. An average grade of not lower than B and no grade lower than C in the courses offered for the degree.

c. A pass in a reading comprehension examination in German or Russian.

2. **Doctor of Philosophy (Geophysical Sciences).** The requirements are:

a. A program of study approved by the student's Advisory Committee, normally consisting of at least nine graduate courses.

b. A pass in a reading comprehension examination in two modern foreign languages, one of which must be Russian or German.

c. A preliminary examination consisting of a written part covering fields that the student has selected for his program of study, followed by an oral part based on the student's proposal for a dissertation topic that he has submitted as a research prospectus.

d. A dissertation by the candidate on the results of independent research in the geophysical sciences, followed by an oral final examination on the dissertation and the field of specialization.

A more detailed statement of the program for the Ph.D. degree is available upon request from the Departmental Counsellor.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES:

131	Introduction to the Geophysical Sciences I	F	3
132	Introduction to the Geophysical Sciences II	W	3
133	Introduction to the Geophysical Sciences III	Sp	3
200	Introduction to Fluid Mechanics	F	3
201	Fluid Mechanics I	F	3
202	Fluid Mechanics II	W	3
203	Fluid Mechanics III	Sp	3
207	Physiochemical Principles	F	3
234	Paleontology	F	3
280	Introduction to Geophysical Dynamics	W	3
281	Waves in the Atmosphere	W	3
282	Waves in the Ocean	W	3

GRADUATE COURSES:

301	Boundary-Layer Theory	F*	3
302	Hydrodynamic Stability	W*	3
303	Turbulence	Sp*	3
304	Dynamics of Rotating Fluids	Sp*	3
305	Experimental Hydrodynamics	W*	3
348	Shallow-Water Oceanography	W, Sp*	3
361	Atmospheric Convection	F	3
362	Numerical Weather Prediction	Sp	3
363	Dynamics of Planetary Atmosphere	Sp	3
381	Tides of the Geosphere	F	3
385	Seminar: Sediment Transport I	F	3

RESEARCH COURSES (Offered Fall, Winter, Spring, Summer):

404	Research in Fluid Mechanics
441	Research in Dynamical Oceanography
461	Research in Dynamical Prediction
462	Research in Hydrodynamical Models
463	Research in Experimental Hydrodynamic Stability
464	Research in Convection
466	Research in Theoretical Fluid Mechanics
481	Research in Marine Geophysics

The instructional staff for the courses listed above consists of the following:

Department of the Geophysical Sciences

Clayton, Robert N., Ph.D., Professor of Geochemistry
Fultz, Dave, Ph.D., Professor of Meteorology and Student Counsellor
Johnson, Ralph G., Ph.D., Professor of Paleontology
Kuo, Hsiao-Lan, Ph.D., Professor of Meteorology
Lindzen, Richard S., Ph.D., Associate Professor of Meteorology
McGoldrick, Lawrence F., Ph.D., Assistant Professor of Fluid Mechanics
Miller, Robert L., Ph.D., Professor of Marine Geophysics and Geology
Pedlosky, Joseph, Ph.D., Associate Professor of Meteorology
Platzman, George W., Ph.D., Professor of Meteorology
Reid, William H., Ph.D., Professor of Applied Mathematics
Witting, James M., Ph.D., Assistant Professor of Hydrodynamics

To obtain further information, address all inquiries directly to:

Dr. Julian R. Goldsmith
Department of the Geophysical Sciences
The University of Chicago
Chicago, Illinois 60637

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*Offered in alternate years

COLUMBIA UNIVERSITY
New York, New York

Graduate students in marine sciences at Columbia University normally enroll in the Department of Geology, those in marine biology enroll in the Department of Biological Sciences. There is no separate Department of Oceanography. Students follow a program of study based on the varied courses offered within these departments. The major research facilities for the marine sciences (along with an extensive oceanographic library and computer facilities) are located at the Lamont-Dougherty Geological Observatory campus of Columbia University in Palisades, New York. At Lamont, research is conducted in physical, chemical, geophysical and biological oceanography as well as solid earth geophysics, geochemistry and meteorology.

The students have access to the material collected on numerous deep-sea expeditions of Lamont ships; among this data is the largest collection of deep-sea cores in the world. The Lamont-Dougherty Observatory carries out oceanographic work aboard the 202-foot 734-ton, 3-masted schooner, VEMA, and the 208-foot 1370-ton AGOR-3, ROBERT D. CONRAD. In addition, polar oceanographic programs are conducted aboard the U.S.N.S. ELTANIN in conjunction with the Office of Antarctic Programs of the National Science Foundation, and the laboratories located on drifting ice in the Arctic Ocean. Columbia University operates a geophysical field station in Bermuda which specializes in the underwater propagation of sound. They conduct field research in the North Atlantic and the Caribbean aboard the vessel, SIR HORACE LAMB.

The degrees of **Master of Arts** and **Doctor of Philosophy** are offered.

The following basic courses are offered by the departments indicated. The exact curriculum to be followed by each student depends on his field of specialization and is decided upon by the student and his advisor.

Geology Department	
*G6881x	Chemical Equilibria in Geologic Systems
†W4928y	Submarine Geology
W4941x	Introduction to Geophysics
G6927x	Oceanography
G6928	Advanced Submarine Geology
G6946y	Elastic Waves
G8928y	Dynamical Oceanography
G8943x	General Geophysics
G9929x or y	Seminar in Physical Oceanography
W4226x	Experimental Marine Sedimentology
G6223y	Principles of Sedimentation
G6945x	Geo-Dynamics
Physics Department	
G4003x	Lagrangian Mechanics
G6019x	Mathematical Methods in Physics
G6051x– G6052y	Advanced Laboratory Work
School of Engineering and Applied Science	
E4201x or y	Partial Differential Equations, I
E4204x or y	Functions of a Complex Variable
E4261x	Basic Continuum Fluid Mechanics
E4262y	Statistical Theory of Turbulence
E6365y	Hydrodynamics
E6367x	Hydrodynamic Stability

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*indicates autumn term
†indicates spring term

Chemistry Department

*G4131x	Introduction to Chemical Physics
†G4133y	Chemical and Statistical Thermodynamics
G4134y	Radiochemistry

Department of Biological Sciences

G6071x	Marine Microbiology
G6074y	Biology of Plankton

The instructional staff for the courses listed above consists of the following:

Alsop, Leonard E., Adjunct Associate Professor
Anderson, Orson L., Professor
Be, Allan W. H., Senior Research Associate, L.G.O.
Broecker, Wallace S., Professor
Donn, William L., Senior Research Associate (Visiting), L.G.O.
Dorman, H. James, Lecturer and Assistant Director, L.G.O.
Drake, Charles L., Professor
Ewing, W. Maurice, Professor and Director, L.G.O.
Garlick, G. Donald, Assistant Professor
Gast, Paul, Professor
Gordon, Arnold L., Assistant Professor
Hays, James D., Assistant Professor
Hunkins, Kenneth L., Lecturer and Senior Research Associate, L.G.O.
Isacks, Bryan L., Adjunct Assistant Professor
Kuo, John T., Associate Professor
McCamy, Keith, Adjunct Lecturer
Nafe, John E., Professor
Oliver, Jack E., Professor
Roels, Oswald, Senior Research Associate, L.G.O.
Sykes, Lynn, Assistant Professor
Talwani, Manik, Associate Professor
Worzel, J. Lamar, Professor and Associate Director, L.G.O.

To obtain further information, address all inquiries directly to:

Professor John E. Nafe
Educational Coordinator
Geology Department
Columbia University
New York, New York 10027

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*indicates autumn term
†indicates spring term

UNIVERSITY OF CONNECTICUT
Storrs, Connecticut

Marine Research Laboratory, Noank, Connecticut

The Laboratory is located at the mouth of the Mystic River (west bank). The main laboratory building is a two-story brick structure and has a concrete deck leading to a T-shaped dock, 125 feet long and 50 feet parallel to the channel. The building contains eight laboratory rooms, darkroom, histological technique room, balance room, library, shop and storerooms. Two additional laboratory rooms are equipped for microbiology and ecology. All basic utilities, including salt water, are supplied to all laboratories. The laboratories contain chemical, radiobiological, climatological and ecological equipment. An electronics shop, complete scuba equipment and some living facilities are in two wooden buildings. Research is primarily in biological oceanography. A 65-foot former T-boat, a 28-foot and a 44-foot cabin cruiser, one 25-foot open launch and several skiffs are available for research work. An assortment of biological and hydrographic collecting gear is used.

Marine Sciences Institute, Avery Point, Groton, Connecticut

The Institute is newly formed, initiating a program in marine sciences in 1968. The Institute is located on the east bank of the mouth of the Thames River at the former Coast Guard Training Center. Two concrete buildings with approximately 48,000 square feet of space are being remodeled for research in physical and chemical oceanography, marine geology and geophysics, atmospheric science, and ocean engineering. The buildings will provide laboratory and office space for Institute staff and students. Two large concrete piers are available near the buildings, which are also being made ready for Institute use. The Institute has two cabin cruisers, one 40 feet long and one 36 feet long, a 24-foot open launch, and is obtaining both a 65-foot steel-hulled T-boat and a skiff. In its first year of operation, the Institute has been making investigations in marine geology and geophysics and in physical oceanography.

Since the Marine Research Laboratory has been doing primarily biological research, the Institute is initiating primarily non-biological programs. The two facilities are seven miles apart and will continue to operate at their present locations, with the Laboratory becoming a division of the Institute on July 1, 1969.

The **Master of Science** and **Doctor of Philosophy** degrees are offered in various departments of the University with specialization in marine science.

The following courses are offered by the departments indicated in conjunction with the above programs. 200 course numbers are for upper division undergraduate credit; 300 course numbers for graduate credit.

Biological Sciences Group			
265	Marine Microbiology	F	3
281	Introductory Phycology	Sp	4
300	Special Problems	F &/or Sp	1–4
303	Special Problems	F &/or Sp	1–4
310	Seminar	F &/or Sp	1
311	Seminar	F &/or Sp	1
317	Marine Ecology	F	3
319	Marine Ichthyology	F	3
320	Advanced Invertebrate Zoology	Sp	4
381	Advanced Phycology	F	3
389	Pathobiology of Invertebrates	F	3
498	Special Readings		0
Civil Engineering			
394	Water Pollution	F, Sp	3
395	Water Pollution		3
401	Ocean Engineering		3

Geology and Geography

217	Sedimentation	F	3
263	Meteorology and Climatology	F	3
264	Physics of the Earth	F	3
265	Methods in Regional Geophysics	Sp	3
272	Physical Oceanography I	F	3
310	Micropaleontology	F	4
370	Physical Oceanography II	Sp	3
371	Chemical Oceanography	Sp	3
400	Special Topics in Geophysics		1–4
410	Special Topics on Geophysics		1–4

The instructional staff for the courses listed above consists of the following:

Biological Sciences Group

Bacteriology

Buck, John D., Ph.D., Assistant Professor of Biology

Botany

Trainor, Francis Rice, Ph.D., Professor of Biology
Page, Joanna (Ziegler), Ph.D., Assistant Professor of Biology

Zoology

Rankin, John S., Jr., Ph.D., Professor of Biology and Director, Marine Research Laboratory
Feng, Sung Yen, Ph.D., Associate Professor of Biology
Franz, David R., Ph.D., Assistant Professor of Biology
Lund, William A., Jr., Ph.D., Assistant Professor of Biology

Geology and Geography

Dehlinger, Peter, Ph.D., Director, Marine Sciences Institute and Professor of Geology
Frankel, Larry, Ph.D., Professor of Geology
Nalwalk, Andrew J., Ph.D., Assistant Professor of Geology
Rumney, George R., Ph.D., Associate Professor of Geography
Thomas, Hugo, Ph.D., Assistant Professor of Geology

Civil Engineering

Widmer, Wilbur, J., S.M., Associate Professor of Civil Engineering

To obtain further information, address all inquiries directly to:

A. Marine Sciences (except biology)

Dr. Peter Dehlinger, Director
Institute of Marine Sciences
University of Connecticut
Southeastern Branch
Groton, Connecticut 06340

B. Biological Oceanography

Dr. John S. Rankin, Jr., Director
University of Connecticut
Marine Research Laboratory
Noank, Connecticut 06340

CORNELL UNIVERSITY
Ithaca, New York

Shoreside laboratory and boat facilities are available at Cayuga Lake. On the Cornell campus special facilities for marine research, such as oceanographic and limnological laboratories, constant temperature rooms, aquarium rooms and experimental fish rearing ponds, are backed up by extensive shop and laboratory facilities, and one of the larger University library systems (over 3 million volumes), with exceptionally rich holdings in marine subjects.

Since 1966 Cornell has offered a summer course in field marine biology at the Isle of Shoals just off the Coast of New Hampshire. In 1969 this course is being expanded, in cooperation with the University of New Hampshire, to provide a broader introduction to all aspects of marine sciences.

The following degrees are offered in the basic sciences:

1. **A.B.** in biology, chemistry, geology, physics
2. **B.S.** in chemical, civil, electrical or mechanical engineering
3. **M.S.** in biology, chemistry, geology, physics
4. **Ph.D.** in biology, chemistry, geology, physics

In addition to basic and supporting courses in chemistry, languages, mathematics, physics, geology, and biology, Cornell undergraduates and graduate students can take regularly scheduled courses covering the areas of general oceanography, marine ecology, invertebrate zoology, marine algae, field marine biology, ichthyology, fishery biology, climatology, sediments, hydrogeology, invertebrate and micropaleontology. Comparative anatomy, animal physiology, and mamalogy are taught by persons with extensive marine experience. Supporting and advanced courses are found in the general areas of limnology, conservation, engineering (Water Resources Center), and maritime law (Law School). Although no regularly scheduled courses exist, Cornell staff includes persons with professional abilities to direct honors programs, individual research, or similar courses in marine bacteriology, marine mycology, marine virology, diseases of marine animals, marine biochemistry, salt marsh ecology, and others.

The following courses are offered in conjunction with the above programs:

B.S.	469	Biology of Fishes
B.S.	316	Invertebrate Zoology
B.S.	344	Biology of the Algae
B.S.	374	Field Marine Biology
B.S.	460	Marine Ecology
B.S.	461	Oceanography
B.S.	470	Ichthyology
Cons.	439	Fish Ecology
Cons.	440	Fishery Science
Cons.	441	Fishery Resource Management
Geol. Sci.	441	Geomorphology
Geol. Sci.	444	Geological Oceanography
Geol. Sci.	551	Geochemistry
Civil Eng.	2301	Fluid Mechanics
Civil Eng.	2315	Advanced Fluid Mechanics
Civil Eng.	2316	Advanced Fluid Mechanics
Civil Eng.	2331	River and Coastal Engineering
Civil Eng.	2512	Microbiology of Water and Waste Water

The instructional staff for the courses listed above consists of the following:

Division of Biological Sciences:

Morison, R.S., M.D., Professor, Director, Division of Biological Sciences
Anderson, John M., Ph.D., Professor of Zoology
Barlow, John P., Ph.D., Associate Professor of Oceanography
Gilbert, Perry W., Ph.D., Professor of Zoology
Kingsbury, John M., Ph.D., Associate Professor of Botany

Division of Biological Sciences–*Continued*

McFarland, William N., Ph.D., Associate Professor of Zoology
Raney, Edward C., Ph.D., Professor of Zoology
Seeley, Harry W., Ph.D., Professor and Chairman Section of Microbiology

Department of Conservation:

Webster, Dwight A., Ph.D., Professor Fishery Biology, Chairman
Carlson, Clarence A., Ph.D., Assistant Professor Fishery Biology
Oglesby, Ray T., Ph.D., Associate Professor of Aquatic Studies

Department of Geological Sciences:

Kiersch, George A., Ph.D., Professor and Chairman
Bloom, Arthur L., Ph.D., Professor of Geological Sciences

Department of Water Resources Engineering:

Gates, Charles D., M.S., Professor and Chairman
Behn, Vaughn C., D. Engineering Associate Professor of Civil Engineering
Dworsky, Leonard B., M.S., Professor Civil Engineering Director, Water Resources Center
Ligget, James A., Associate Professor Civil Engineering
Brutseart, Wilfried, Associate Professor Civil Engineering

To obtain further information, address all inquiries directly to:

Dr. R. S. Morison, Director
Division of Biological Sciences
Cornell University
Ithaca, New York 14850

THE UNIVERSITY OF DELAWARE
Newark, Delaware

The University of Delaware Marine Laboratories form a part of the Department of Biological Sciences and have major facilities at two centers: a Marine Biology Laboratory on the University campus at Newark where the office of the Laboratories' director, library, class rooms, and research facilities are located and the Field Station facilities located in Lewes, Delaware, at the mouth of Delaware Bay. The Field Station comprises three laboratories: Bayside Laboratory, which is a research facility; the Shellfish Culture Laboratory, which is equipped for year-round operation in the rearing of shellfish under controlled conditions; and the Cape Henlopen Laboratory, which is being developed for summer course work and research.

The 46-foot R/V **Wolverine** is equipped as a stern trawler capable of doing trawling, dredging and light coring, and has davits and booms for hydrographic and plankton collections. It is equipped with 110v. AC, Loran, radar, berths and accommodations for five, two crew and three scientists. In addition there are several smaller boats with outboard motors.

The following degrees are offered by the University:

Department of Biological Sciences:

1. **Bachelor of Science**—at least 30 semester hours which include the 5 core courses: B 201—Concepts in Biology, B 202—Developmental Biology, B 301—Cellular and Molecular Biology, B 302—Environmental Biology, and B 303—Genetic and Evolutionary Biology. These biology courses are supplemented with courses in chemistry, mathematics and physics, and one foreign language.
2. **Master of Science**—30 hours credit including research, thesis, reading knowledge of one foreign language.
3. **Doctor of Philosophy (with specialization in Marine Biology)**—course work deemed necessary by Advisory Committee, independent research work with dissertation, and reading knowledge of 2 foreign languages, one of which could be substituted for by computer science.

Department of Geology:

1. **Bachelor of Science**—at least 30 credit hours which include GEO 105-6—General Geology, 201-2—Mineralogy and Optical Mineralogy, GEO 301—Paleontology, GEO 302—Sedimentation and Stratigraphy, GEO 304—Igneous and Metamorphic Petrology, and GEO 403—Structural Geology. These courses are supplemented by courses in physics, chemistry, and mathematics, and one foreign language.
2. **Master of Science**—
   - A. Demonstrated ability to read scientific literature in one foreign language.
   - B. A qualifying written examination to be taken at least nine months before the date of anticipated graduation.
   - C. An oral examination administered by the student's thesis committee after completion of the M.S. thesis.
3. **Doctor of Philosophy**—
   - A. The general requirements imposed by the University.
   - B. Oral and written qualifying examinations in which the student demonstrates
     - i. the breadth and depth of his knowledge of major geologic phenomena and processes;
     - ii. his knowledge of his field of specialization (e.g., sedimentation—stratigraphy, marine geology, geochemistry) within the broader field of geology;
     - iii. his knowledge of a minor field related to his area of specialization. The student's committee will include, if possible, an outside examiner.

The following courses are offered in conjunction with the above programs:

Department of Biological Sciences:

B 627	Introductory Oceanography	F	4
B 628	Marine Biology	Su	6
B 629	Physical Oceanography	Su	3

Department of Biological Sciences–*Continued*

B 630	Ichthyology	*	4
B 631	Biological Oceanography	F	4
B 634	Ivertebrate Zoology	*	4
B 638	Marine Botany	Su	3
B 639	Topics in Marine Ecology		3
B 827	Colloquium in Marine Sciences (Offered each year on different topics; may be repeated with each change of topic)		2–4
B 828	Marine Invertebrates	*	4
B 838	Marine Fouling		3
B 866	Special Problem: Tidal Marsh Studies		3

Geology Department

GEO 301	Paleontology	F	4
GEO 302	Sedimentation and Stratigraphy	Sp	4
GEO 406	Introduction to Geophysics	Sp	3
GEO 601	Advanced General Geology	F	2
GEO 602	Advanced General Geology	Sp	2
GEO 631	Marine Geology		3
GEO 632	Recent Sedimentary Environments	Su	3
GEO 646	Geochemistry		3
GEO 805	Petrology of Sedimentary Rocks	F*	3
GEO 806	Micropaleontology	Sp*	4
GEO 811	Stratigraphy	F*	3
GEO 814	Introduction to Geophysics	Sp*	3

The University also offers undergraduate and graduate programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Marine Laboratories:

Daiber, Franklin C., Ph.D., Professor of Biology and Director, Marine Laboratories; ichthyology and ecology.

Wells, Harry W., Ph.D., Associate Professor; invertebrate zoology; marine ecology.

Price, Kent S., Ph.D., Assistant Professor and Director of the Field Station; physiology of fish; marine ecology.

Maurer, Donald L., Ph.D., Assistant Professor; marine ecology; biology of marine shellfish.

Myers, Thomas D., Ph.D., Assistant Professor; biological oceanography; marine ecology.

Taylor, Jonathan, Ph;D., Assistant Professor; marine biology; algology.

Geology Department:

Jordan, Robert R., Ph.D., Assistant Professor; stratigraphy; sedimentary petrology; study of suspended matter; Pleistocene shorelines.

Kraft, John C., Ph.D., Associate Professor; recent sedimentary environments; Delaware coast; paleoecology.

Sheridan, Robert E., Ph.D., Assistant Professor; marine geophysics.

Pickett, T. E., Ph.D., Assistant Professor; marine sedimentation.

To obtain further information, address all inquiries directly to:

Dr. Franklin C. Daiber
Director, Marine Laboratories
University of Delaware
Newark, Delaware 19711

Dr. John C. Kraft
Department of Geology
University of Delaware
Newark, Delaware 19711

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*Offered in alternate years

DUKE UNIVERSITY
Durham, North Carolina

The Duke University Marine Laboratory (DUML) is an interdepartmental and interuniversity facility for training and research in the marine sciences. It is open throughout the year with an academic and technical staff in residence. It presently occupies fifteen acres of the southern portion of Pivers Island, Beaufort, North Carolina. The U.S. Bureau of Commercial Fisheries Biological and Radiobiological Laboratories encompass the remainder of the island, the northern end. The present plant consists of eighteen buildings, including three dormitories capable of housing forty-six people, a large dining hall, two residences, boat house, store house for ship's gear, classroom laboratories and five air-conditioned research buildings.

The station operates a well-equipped 118-foot research vessel EASTWARD for training and research in oceanography, a 55-foot trawler for off-shore investigations, and a 39-foot cabin powerboat for trawling and dredging in surrounding sounds and estuaries. A 17-foot fiberglass speedboat, rowboats with outboard motors, and collecting gear are also available. The DUML library receives 125 current periodicals and is complemented by added holdings of the Bureau of Commercial Fisheries Laboratories and the University of North Carolina Institute of Marine Science which are located in the Beaufort-Morehead City area.

Separate degrees are not offered in the marine sciences, but a student may pursue work for the **A.M. and Ph.D. degrees in Botany and Zoology with concentration of courses in Marine Biology and Oceanography** and a thesis in one of these areas. For **the A.M. degree in Geology**, course work may be taken and a thesis written in Marine Geology or Geological Oceanography.

In Botany the student's graduate program is planned to provide broad basic training in the various fields of botany, plus intensive specialization in the field of the research problem. Graduate courses in the Department of Geology are designed to provide training in the field of environmental sedimentary geology with specialized training in bio-environments, litho-environments, or modern environments.

Required work for the A.M. degree in zoology ordinarily includes 12 units of advance course work in zoology, 6 units of course work in a minor department, and an additional 6 units of advanced work in the major or minor department, or in other pertinent departments. Furthermore, an acceptable thesis is necessary for the fulfillment of the degree requirements.

Normally the program for the Ph.D. degree includes graduate courses in several fields of zoology, courses in the minor subject, wide reading in science in general and in biology in particular, research, and a dissertation based on original work. Minor work is available in many fields, including anatomy, biochemistry, botany, chemistry, geology, physics, physiology and psychology.

A graduate student working for the Ph.D. degree usually takes course work on the main Durham Campus during the academic year and more specialized courses in the summer in the marine sciences at the Duke University Marine Laboratory. By the end of his second year, he is expected to have passed an oral preliminary examination in his department. Thereafter, he is free to do his thesis research without further course requirements on the Durham and/or DUML campuses.

Training in the marine sciences at Duke University and the Duke University Marine Laboratory is at the senior-graduate level in the departments of Botany, Geology and Zoology. Students are free to elect courses in any of the science departments including those in the Schools of Medicine and Engineering.

The following courses are offered in conjunction with the above programs:

Botany–Senior-Graduate

207	Marine Mycology	Su	6
211	Marine Phycology	Su	6
220	Coastal Field Botany (when required)	Su	6
225–226	Special Problems	Su	6
255	Plant Systematics	Sp	4
259	The Environment	F	4
	Seminar	F, Sp	

Graduate

359–360	Research in Botany		

Geology–Senior-Graduate

204	Physical Oceanography	Su	6
205	Geological Oceanography	Su	6
222	Sedimentary Minerals	F, Sp	3
235	Carbonate Sedimentation and Geochemistry	F	3
241–242	Invertebrate Paleontology	F, Sp*	6
243–244	Micropaleontology	F, Sp*	6
247	Paleoecology	F, Sp*	3
305	Physical Environments Seminar		

Zoology–Senior-Graduate

203	Marine Ecology	Su	6
214	Biological Oceanography	F	6
216	Limnology	Sp	3–4
238	Systematic Zoology	F	4
240	Chemical Oceanography (Chemistry 240)	Su	6
250	Physiological Ecology of Marine Animals	Su	6
274	Marine Invertebrate Zoology	Su	6
278	Invertebrate Embryology (when required)		4 or 6

Graduate

351, 352	Departmental Seminar	F, Sp	
353, 354	Research		
355, 356	Seminar		
	Advanced Oceanographic Seminar		

The instructional staff for the courses listed above consists of the following:

BOTANY DEPARTMENT

Johnson, Terry W., Ph.D., Chairman and Professor of Botany, Marine Mycology
Billings, William Dwight, Ph.D., James B. Duke Professor of Botany, Plant Ecology
Searles, Richard B., Ph.D., Assistant Professor of Botany, Marine Phycology
Wilbur, Robert L., Ph.D., Associate Professor of Botany, Plant Systematics

GEOLOGY DEPARTMENT

Heron, Stephen Duncan, Ph.D., Chairman and Associate Professor of Geology, Sedimentary Petrology
Blanton, Jackson O., Ph.D., Assistant Professor of Geology, Physical Oceanography
Lynts, George W., Ph.D., Assistant Professor of Geology, Micropaleontology
Perkins, Ronald, Ph.D., Associate Professor of Geology, Sedimentology
Pilkey, Orrin H., Ph.D., Associate Professor of Geology, Marine Geology

ZOOLOGY DEPARTMENT

Horn, Edward C., Ph.D., Chairman and Professor of Zoology, Cytochemistry
Bailey, Joseph R., Ph.D., Professor of Zoology, Vertebrate and Systematic Zoology
Bookhout, Cazlyn G., Ph.D., Professor of Zoology & Acting Director of Oceanographic Program, Invertebrate Embryology and Zoology
Costlow, John D., Jr., Ph.D., Professor of Zoology and Director of Duke University Marine Laboratory, Invertebrate Embryology and Zoology
Doyle, Roger, Ph.D., Assistant Professor of Zoology, Ecology and Biological Oceanography
Fluke, Donald J., Ph.D., Professor of Zoology, Biophysics
Gray, Irving E., Ph.D., Professor of Zoology (Retired), Ecology
Hunter, Wanda S., Ph.D., Associate Professor of Zoology (Retired), Marine Parasitology
Livingstone, Daniel A., Ph.D., Professor of Zoology, Limnology

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*Given Biennially

Stefansson, Unsteinn, Ph.D., Adjunct Professor of Zoology, Chemical Oceanography

Vernberg, F. John, Ph.D., Professor of Zoology & Assistant Director of Duke University Marine Laboratory, Physiological Ecology

Wainwright, Stephen A., Ph.D., Associate Professor of Zoology, Invertebrate Zoology

Wilbur, Karl M., James B. Duke Professor of Zoology, Cellular Physiology

Applications. A student who wishes to apply for graduate work at Duke University should write to the Director of Graduate Studies of the Department of his particular interest, Duke University, Durham, N. C. 27706, or the Dean of the Graduate School for a graduate catalogue and application blanks. Applications for Graduate School should be submitted before February 1.

Students who wish to attend summer courses at Duke University Marine Laboratory should write Dr. John D. Costlow, Jr., Director, Duke University Marine Laboratory, Beaufort, N. C. 28516, for a bulletin and application blank. Applications should be completed before March 10.

FLORIDA ATLANTIC UNIVERSITY
Boca Raton, Florida

Florida Atlantic University offers ocean engineering and marine science courses at its main campus in Boca Raton, Florida. Florida Atlantic University is an upper division university (junior and senior years plus graduate work) which includes a College of Science and a separate Department of Ocean Engineering. It is a part of the State of Florida University system. Students entering FAU must have successfully completed two years at a junior college or the equivalent at a four year institution and meet the prerequisites of the department they desire to enter.

The Department of Biological Sciences is housed in a new five-story building which includes modern laboratory facilities for teaching and research in the areas of botany, microbiology, and zoology. Faculty interest and research are strongly oriented toward tropical inshore marine biology with particular emphasis on ecology and environmental contamination. In addition to the campus facility, the Department, in association with the Sanibel-Captiva Conservation Foundation, operates a marine research station on Pine Island Sound, Sanibel Island, on the southwest coast of Florida. Inshore collecting boats, laboratory space, and student housing are available.

Joint graduate training programs and marine science seminars are also conducted through direct affiliation of the Department with the U. S. Bureau of Commercial Fisheries Tropical Atlantic Biological Laboratory in Miami. The Department also houses the newly established Environmental Contamination Data Center which operates in close conjunction with the marine sciences programs of the University and with similar programs at many national institutions.

The University offers the degree of **M.S. in Biological Sciences (Department of Biological Sciences).** All students are required to obtain practical research experience in biological sciences with an emphasis in the area of botany, microbiology, or zoology, and to demonstrate competence in one of these areas by satisfactorily completing a comprehensive examination and thesis research. Each student is required to satisfactorily complete a minimum of forty-five (45) quarter credit hours of courses, six of which may be in undergraduate-level courses, including up to six quarter credits of thesis research. Each student must also demonstrate a reading knowledge of a modern foreign language, usually French, German, or Russian.

Courses in the marine sciences are offered during the academic year by the departments of Biological Sciences, Geography (Geology), and Ocean Engineering. Both Biological Sciences and Ocean Engineering offer regular summer and special workshop courses on the Boca Raton campus.

The following courses are offered by the Department of Biological Sciences in conjunction with the M.S. Program (the credits shown are quarter hours).

315	Marine Biology for Ocean Engineers	3
431	Thallophytes	5
446	Invertebrate Zoology I	4
447	Invertebrate Zoology II	4
495	Introduction to Marine Biology	4
504	Special Probelms	4
517	Microbial Ecology	5
526	Algology	5
535	Marine Invertebrate Zoology I	4
536	Marine Invertebrate Zoology II	4
543	General Ichthyology	4
544	Biological Ichthyology	4
554	Physiological Animal Ecology	5
556	Aquatic Ecology	5
599	Master's Thesis Research	6

The University also offers an undergraduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Biological Sciences

- Boss, Manley L., Ph.D., Chairman and Professor of Botany
- Adams, Ralph M., Ph.D., Assistant Professor of Biology
- Courtenay, Walter R., Jr., Ph.D., Assistant Professor of Zoology
- Dobkin, Sheldon, Ph.D., Assistant Professor of Zoology
- Domey, Richard G., Ed.D., Professor of Biostatistics
- Grimm, Robert B., Ph.D., Assistant Professor of Botany
- Hoffman, Harrison A., Ph.D., Professor of Microbiology
- Kalber, Frederick A., Ph.D., Associate Professor of Zoology
- Sguros, Peter L., Ph.D., Professor of Microbiology
- Waddell, Glenn H., Ph.D., Assistant Professor of Microbiology

Affiliate Faculty

Tropical Atlantic Biological Laboratory

- Beardsley, Grant, Ph.D., Fishery Research Biologist
- Berry, Frederick A., M.S., Research Systematist
- Dragovich, Alexander, M.S., Fishery Research Biologist
- Hebard, James Frank, Ph.D., Oceanographer
- Houde, Edward D., Ph.D., Fishery Research Biologist
- Ingham, Merton C., Ph.D., Program Chief, Physical Oceanography Program
- Jones, Albert C., Ph.D., Assistant Laboratory Director
- Miller, George C., M.S., Research Systematist
- Miller, Robert V., Ph.D., Zoologist (Fishes)
- Richards, William J., Ph.D., Program Chief of the Developmental Biology of Fishes
- Sindermann, Carl J., Ph.D., Laboratory Director
- Wilson, Peter C., B.S., Fishery Biologist
- Wise, John P., M.S., Program Chief of the Tuna Biology Program

To obtain further information, address all inquiries directly to:

Dr. S. E. Wimberly
Vice-President for Academic Affairs
Florida Atlantic University
Boca Raton, Florida 33432

FLORIDA INSTITUTE OF TECHNOLOGY
Melbourne, Florida

The Institute offers a program in Physical Oceanography. Courses and research in the other fields of marine science and cooperative programs with other institutions emphasize the interrelationships between the various marine sciences. Nine buildings were completed recently and a new science building is scheduled for completion in 1969 to house the 10,000 curie cobalt facility, a 5 million volt linear accelerator, and a subcritical nuclear reactor, as well as classrooms, labs, and faculty offices. A laboratory for the program in physical oceanography will be included in the new science building, as well as a soil mechanics lab to study sound transmission in sediments, an instrument development lab, and a wet analysis chemistry lab. Currently in operation is an 18 foot Fleetwing, FLIT, which is used in coastal surveys. FIT has a computer center equipped with a model 2B IBM 1130 Computer which supports the scientific processing needed for its research projects.

The following degrees are offered by the Institute:

1. **M.S. in Physical Oceanography (Department of Oceanography)**

The degree of Master of Science in Oceanography may be conferred upon students who have successfully completed a minimum of forty-eight (48) quarter hours of required and elective work. Applicants for admission to the program should have a Bachelor's degree in physics, mathematics, physical science, or engineering from an institution acceptable to the Graduate School. All Physical Oceanography graduate students are required to have a mathematical background through differential equations and one year of chemistry.

A graduate record examination is required for all students seeking the Master of Science degree unless waived by the Dean of the Graduate School.

Admission to the Graduate School does not imply that the work taken by the student will be credited toward a degree. No commitment in this matter has been made until the student is admitted to candidacy for a degree.

The part-time Master of Science candidate in oceanography may either take a comprehensive written and oral examination or write a Master's thesis. Full time graduate students are required to write a Master's thesis.

2. **B.S. in Physical Oceanography (Department of Oceanography)**

In addition to a basic program in physics, undergraduate students will take such courses as introduction to oceanography, marine geology and geophysics, physical oceanography, marine meteorology, ocean waves, and hydroacoustics. Some field work will be included and each student must write an undergraduate thesis.

The following courses in the marine sciences are offered during the year by the Department of Oceanography. In addition to the programs conducted on campus, FIT also conducts an annual course in Underwater Photography.

Florida Institute of Technology holds a 6 weeks pre-college summer institute for high school seniors and graduates who desire additional training in science and mathematics before entering college. The Institute gives the student special courses in Mathematics, Physics, Chemistry, Oceanography, Space Technology, and English. A special guidance and testing seminar assists the students in discovering the fields for which they are best suited.

O301	Introduction to Oceanography	3
O302	Chemical Oceanography	3
O303	Physical Oceanography	4
O401	Marine Geology	3
O402	Ocean Waves and Currents	3
O403	Marine Geophysics	3
O410, 411	Seminar	1
O451	Hydroacoustics	3
O452	Marine Meteorology	2
O491	Senior Project	3

O500	Introduction to Physical Oceanography	3
O501	Geological Oceanography	3
O502	Biological Oceanography	3
O503	Chemical Oceanography I	3
O504	Chemical Oceanography II	3
O506	Sea Laboratory Techniques	2
O510	Seminar	1
O511	Tides and Tidal Currents	1
O512	Dynamic Oceanography I	3
O513	Dynamic Oceanography II	3
O514	Dynamic Oceanography III	3
O515	Engineering Aspects of Oceanography	3
O516	Marine Meteorology	3
O517	Marine Thermodynamics	3
O520	Hydroacoustics I	3
O521	Hydroacoustics II	3
O530	Geotechnical Properties of Marine Sediments	3
O531	Ocean Waves	3
O532	Wind Waves	3
O540	Statistical Methods in Oceanography	3
O550, 551, 552	Special Topics in Physical Oceanography	1
O560, 561	Partial Differential Equations for Physical Oceanography	3
O597, 598, 599	Thesis	3

The instructional staff for the courses listed above consists of the following:

Department of Oceanography

Morelock, Jack, Ph.D., Chairman and Professor of Oceanography
Dubbledam, Pieter S., Ph.D., Associate Professor of Oceanography and Physics
Hall, Sheldon R., M.S., Lecturer in Oceanography
Herrera, Luis E., Ph.D. Candidate, M.S., Assistant Professor of Oceanography
Lasater, James A., Ph.D., Professor of Oceanography
Phillips, David R., M.S., Adjunct Lecturer in Oceanography
Webster, George C., Ph.D., Adjunct Professor of Oceanography
Woodbridge, David, Ph.D., Director of Research

To obtain further information, address all inquiries directly to:

Dean, Graduate School
Florida Institute of Technology
Melbourne, Florida 32901

FLORIDA STATE UNIVERSITY
Tallahassee, Florida

The Department of Oceanography, a part of the Science Center at the main campus, offers a graduate program leading to the M.S. and Ph.D. degrees in all phases of oceanography. It presently occupies approximately 20,000 square feet of space in temporary buildings. A wide range of equipment, including a CDC 2400 Computer Center, is available within the Department and science center for all phases of oceanographic research and teaching.

A shore facility at Turkey Point on the Gulf of Mexico, 46 miles from the campus, was dedicated in November, 1968. The facility, with a 180' x 200' boat basin, will accommodate vessels of draft less than 12 feet. The facility will provide a 180' dock, large air-conditioned shop, a laboratory of 8,500 square feet with running sea water, and dormitory space. An air-conditioned 65-foot vessel with collecting equipment, a 30-foot cabin cruiser and several small boats are available for inshore work. Within the Department of Geology is the National Science Foundation Antarctic Marine Geological Research Facility for storing and processing Antarctic sediments.

The Department of Oceanography offers an interdisciplinary program leading to the **Master of Science and Doctor of Philosophy degrees in the fields of biological, chemical, geological, and physical oceanography.**

The following courses are offered in conjunction with the above programs:

500	Elementary Physical Oceanography	3
501	Introduction to Physical Oceanography	3
502	Dynamic Oceanography	3
503	Classical Hydrodynamics	3
504	Marine Hydrodynamics	3
505	Ocean Waves	3
506	Ocean Circulation	3
507	Turbulence	3
508	Geophysical Measurements	3
509	Estuary and Coastline Hydrodynamics	3
514	Dynamics of the Upper Ocean	3
515	Experimental Oceanography	4
520	Elementary Biological Oceanography	3
522	Ecology and Taxonomy of Benthic Communities	3
523	Zooplankton Ecology	3
524	Marine Phytoplankton Ecology	3
525	Marine Phytoplankton Physiology	3
527	Fishery Biology	3
530	Marine Ecology	12
535	Estuarine Pollution	3
540	Elementary Chemical Oceanography	3
541	Marine Chemistry	3
545	Chemical Limnology	3
557	Physics of the Air-Sea Boundary Layer	3
558	Laboratory in Air-Sea Interaction	5
561	Oceanic Zoogeography	3
562	Geomicrobiology	3
564	Marine Microbiology	4
570	Elementary Geological Oceanography	3
571, 572	Geochemistry	3, 3
574, 575	Shoreline Geology	3, 2
580	Advanced Sedimentology	4
581	Bathymetry, Structure, and Tectonics of the Ocean Basins	4

582	Oceanic Processes of Sedimentation	3
583	Ocean Sediments	3
584, 585	Theoretical Hydrodynamics	3, 3
586	Environments of Marine Deposition	4
591	A, B, C, D. Directed Individual Study	12, 12, 12, 12
595	A, B. Seminar	1, 1
597	A, B, C. Directed Research	3, 3, 3
598	A, B, C. Directed Teaching	3, 3, 3
599	Thesis	5–9
629	A, B, C. Advanced Topics in Geophysical Fluid Dynamics	3, 3, 3
695	A, B. Seminar	1, 1
699	Doctoral Dissertation	18–

The instructional staff for the courses listed above consists of the following:

Oppenheimer, Carl H., Ph.D., Professor, Chairman, Biological Oceanography
Ashby, Ebert A., Ph.D., Associate Professor, Biological Oceanography
Garstang, Michael, Ph.D., Associate Professor and Assistant Chairman, Physical Oceanography
Glooschenko, Walter A., Ph.D., Assistant Professor, Biological Oceanography
Goodell, H. Grant, Ph.D., Professor, Director of Antarctic Marine Geology Research Facility; Marine Geology and Geochemistry
Greenberg, Michael J., Ph.D., Research Associate in Oceanography and Associate Professor in Biological Sciences, Biological Oceanography
Hadlock, Ronald K., Ph.D., Assistant Professor Meteorology and Oceanography, Physical Oceanography
Harriss, Robert C., Ph.D., Assistant Professor, Chemical Oceanography
Hsueh, Ya, Ph.D., Assistant Professor, Physical Oceanography
Jones, James I., Ph.D., Associate Professor, Geological Oceanography
Krishnamurti, Ruby E., Ph.D., Assistant Professor Oceanography, and Senior Research Associate Geophysical Fluid Dynamics Institute, Physical Oceanography
Kritzler, Henry, Ph.D., Professor, Marine Ecology
La Rock, Paul A., Ph.D., Assistant Professor, Geomicrobiology
Light, Robley J., Ph.D., Assistant Professor Chemistry and Research Associate in Oceanography, Chemical Oceanography
Menzel, R. Winston, Ph.D., Associate Professor, Marine Biology
Menzies, Robert J., Ph.D., Professor, Biological Oceanography
Staley, Raymond C., Ph.D., Associate Professor, Physical Oceanography
Warnke, Detlef A., Ph.D., Assistant Professor, Geological Oceanography
Warsh, Kenneth L., Ph.D., Assistant Professor, Physical Oceanography

To obtain further information, address all inquiries directly to:

Dr. Carl H. Oppenheimer
Chairman
Department of Oceanography
Florida State University
Tallahassee, Florida 32306

UNIVERSITY OF FLORIDA
Gainesville, Florida

The University of Florida Marine Laboratory on Seahorse Key, an island about two miles from Cedar Key, consists of a laboratory with fresh and sea water and a ten-room building used as a dormitory and caretaker's quarters.

The University offers the degrees of **M.S. and Ph.D. in Geology and Zoology**. No specific degrees are offered in Marine Sciences.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

Department of Zoology

308	Invertebrate Zoology	5
309	Comparative Vertebrate Anatomy	5
310	Embryology	5

Department of Geology

517	Marine Geology	4

GRADUATE COURSES

Department of Zoology

612	Marine Ecology	4
641	Comparative Physiology	5
651	Ichthyology	4

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Geology

Brooks, Harolds K., Ph.D., Associate Professor of Geology

Department of Zoology

Brookbank, John W., Ph.D., Associate Professor of Zoology
De Witt, Robert, Ph.D., Associate Professor of Zoology
Gilbert, Carter R., Ph.D., Assistant Professor of Zoology
Maturo, Frank J. S., Ph.D., Associate Professor of Zoology
Nordlie, Frank G., Ph.D., Associate Professor of Zoology
Pierce, E. Lowe, Ph.D., Professor of Zoology and Supervisor of Marine Laboratory

To obtain further information, address all inquiries directly to:

Department of Geology

Dr. H. K. Brooks
Department of Geology
University of Florida
Gainesville, Florida 32601

Department of Zoology

Dr. E. Lowe Pierce
Department of Zoology
University of Florida
Gainesville, Florida 32601

UNIVERSITY OF SOUTH FLORIDA
MARINE SCIENCE INSTITUTE
St. Petersburg, Florida

The Marine Science Institute of the University of South Florida is located at the Bay Campus in St. Petersburg. The Institute is an interdisciplinary unit involving the cooperation of seven associated departments in three divisions of the University.

The Bay Campus occupies a peninsula about one block wide and two blocks long that extends into Bayboro Harbor, a protected bay opening into Tampa Bay. There are 15 buildings of various sizes with more than 200,000 square feet of floor space. Offices and laboratories are located in the main building. There are five new marine science teaching laboratories and six research laboratories, classrooms, living quarters for about 20 visiting investigators, an auditorium, and many other facilities.

Excellent docking and servicing facilities for oceanographic vessels and smaller boats surround the Bay Campus. The Institute operates a 38-foot catamaran, several smaller boats, and has access to the Florida Board of Conservation's 72-foot trawler. At the dockside is a concrete porpoise tank with water filtration system.

No degree is, as yet, offered by the Institute. (A Master's degree is proposed for the 1969-70 academic year.)

The following courses are offered:

BOT 447	Marine Botany	4
BOT 543	Phycology	5
BOT 583	Marine Microbiology	4
BOT 643	Advanced Phycology	4
CHM 613	Chemistry of the Less Familiar Elements	4
GLY 503	Sedimentation I	3
GLY 504	Sedimentation II	3
GLY 604	Recent Fluvial, Transitional, and Continental Shelf Sedimentation	3
GLY 605	Advanced Sedimentation	3
GLY 621	Marine Micropaleontology	6
OGY 311	Introduction to Oceanography	3
OGY 521	Chemical Oceanography	4
OGY 531	Geological Oceanography	4
OGY 541	Physical Oceanography	4
OGY 551	Biological Oceanography	4
ZOO 519	Ichthyology	5
ZOO 523	Physiology of Marine Animals	5
ZOO 533	Physiology of Fishes	4
ZOO 546	Marine Invertebrate Zoology I	5
ZOO 547	Marine Invertebrate Zoology II	5
ZOO 613	Advanced Invertebrate Zoology	3
ZOO 614	Plankton Ecology	4
ZOO 615	Plankton Systematics	4
ZOO 619	Advanced Ichthyology	5

The instructional staff for the courses listed above consists of the following:

Humm, Harold J., Ph.D., Director, and Professor of Marine Science
Betz, John V., Ph.D., Assistant Professor of Botany and Bacteriology
Briggs, John C., Ph.D., Chairman and Professor of Zoology
Bloch, S. C., Ph.D., Associate Professor of Physics
Dawes, Clinton J., Ph.D., Associate Professor of Botany
DeWitt, Hugh H., Ph.D., Assistant Professor of Marine Science
Flynn, Robert W., Sc.D., Assistant Professor of Physics

Friedl, Frank E., Ph.D., Associate Professor of Zoology
Griffin, George M., Ph.D., Associate Professor of Geology
Hopkins, Thomas L., Ph.D., Assistant Professor of Marine Science
Lawrence, John M., Ph.D., Assistant Professor of Zoology
Linton, Joe R., Ph.D., Associate Professor of Zoology
Martin, Dean F., Ph.D., Associate Professor of Chemistry
Simon, Joseph L., Ph.D., Assistant Professor of Zoology
Strong, Paschal, Ph.D., Professor of Psychology
Taft, William H., Ph.D., Director and Associate Professor, Sponsored Research; Assistant Dean of Academic Affairs
Wagner, Diane, Ph.D., Assistant Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Harold J. Humm
Director
Marine Science Institute
University of South Florida
830 First Street South
St. Petersburg, Florida 33701

UNIVERSITY OF WEST FLORIDA
Pensacola, Florida

This upper division University offers Marine Science oriented courses on its 1000-acre main campus. The University has research facilities on the main campus, and shares the facilities of the Bureau of Commercial Fisheries Field Station on Sabine Island located on Santa Rosa Island. To implement this University's commitment to the estuarine environment, its research vessel is the ARGONAUT, a 23-foot inboard-outdrive vessel, which is trailerable and especially equipped for estuarine study.

The University offers the degree of **B.S. in Biology and Marine Sciences** through its Department of Biology and Marine Sciences.* All students are required to meet standard university requirements for academic residence and complete a minimum of 60 hours of junior/senior level work. The student must complete By 310, 311, 320, 321, 343, and 443 plus an additional 20 hours of Marine Sciences related courses.

The following courses in Biology and Marine Sciences are offered in all four academic quarters on the main campus by the Faculty of Biology and Marine Sciences:

By 310	Molecular Biology	5
By 311	Genetics	5
By 320	Cell Biology	5
By 321	Developmental Biology	5
By 343	Organismic Biology	5
By 440	Marine Invertebrate Zoology	5
By 443	Aquatic Ecology	5
By 445	Aquaculture	5
By 446	Aquatic and Marine Botany	5
By 360–379	Seminar	Variable
By 399	Directed Study	Variable

The instructional staff for the courses listed above consists of the following:

Faculty of Biology and Marine Sciences

Hopkins, Thomas S., Ph.D., Coordinator of Marine Sciences and Associate Professor of Biology and Marine Sciences

Baylis, John R., Ph.D., Assistant Professor of Biology and Marine Sciences

Butler, Philip A., Ph.D., Associate Faculty, Faculty of Biology and Marine Sciences

Cates, Norman B. Ph.D., Assistant Professor of Biology and Marine Sciences

Chaet, Alfred B., Ph.D., Professor, Biology and Marine Sciences

D'Asaro, Charles N., Ph.D., Assistant Professor of Biology and Marine Sciences

Duke, Thomas W., Ph.D., Associate Faculty, Faculty of Biology and Marine Sciences

Gifford, Charles A., Ph.D., Assistant Professor of Biology and Marine Sciences

Reid, Roger D., Ph.D., Professor, Biology and Marine Sciences

Walsh, Gerald E., Ph.D., Associate Faculty, Faculty of Biology and Marine Sciences

To obtain further information, address all inquiries directly to:

Dr. Alfred B. Chaet
Provost, Gamma College
Professor of Biology and Marine Sciences
The University of West Florida
Pensacola, Florida 32504

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*An M.S. in Marine Science is proposed for the 1969-70 academic year.

FRESNO STATE COLLEGE
Fresno, California

In its marine science program the college provides "on campus" courses in Oceanography and Marine Geology. These courses provide the prerequisites and background training for additional instruction on the undergraduate or graduate level at the California State Colleges Marine Laboratories at Moss Landing, California. Classes are conducted both on the home campus in Fresno and at the Marine Station, Moss Landing Marine Laboratories (for detailed information on the Laboratories, consult the **Consortia** section).

The following degrees are offered:

1. **Bachelor of Arts with emphasis in Marine Science**
2. **Master of Arts with emphasis in Marine Science (thesis required).** Students may specialize in biology or geology.

The biology, chemistry and geography departments, as well as geology and physics, present foundational courses for students, emphasizing marine science in their programs.

The following courses are offered in conjunction with the above programs:

Phy. 140	Comparative Animal Physiology		4
Zool. 118	Advanced Invertebrates		3
Geog. 205	Seminar in Regional Geography		3
Geol. 109	General Oceanography	Sp	4
Geol. 120	Marine Geology	F	3

The instructional staff for the courses listed above consists of the following:

Biology Department

Tribbey, Bert A., Ph.D., Assistant Professor, Ecology, Invertebrates
Woodwick, Keith H., Ph.D., Professor, Systematics, Invertebrates

Geography Department

Norsworthy, Stanley, C.Phil., Assistant Professor, Coastal Vegetation

Geology Department

White, Stanton, Ph.D., Assistant Professor, Oceanography, Marine Geology

To obtain further information, address all inquiries directly to:

Dr. Stan W. White (for Fresno State College)
Department of Geology
Fresno State College
Fresno, California 93726

or

Dr. Keith Woodwick (for Fresno State College)
Department of Biology
Fresno State College
Fresno, California 93726

or

Moss Landing Laboratories
P. O. Box 223
Moss Landing, California 95039

THE GEORGE WASHINGTON UNIVERSITY
Washington, D. C.

The University offers marine science courses at its main campus in downtown Washington, D. C. and at a number of government installations in the greater Washington area.

The University offers the degree of **B.S. in Oceanography** through its Columbian College.

All students are required to satisfy many of the undergraduate requirements for the Bachelor of Science degree. In addition specialization in oceanography is obtained by taking 21 hours in oceanography and additional work in geology and geophysics.

The following courses in the marine sciences are offered by the Departments of Mathematics and Geology. The program is administered by the Department of Mathematics under the guidance of a Program Adviser.

OCEA 12	Navigation	3
OCEA 101–2	Elementary Oceanography	3–3
OCEA 110	Ocean Dynamics	3
OCEA 111	Ocean Waves and Tides	3
OCEA 112	Biological Oceanography	3
OCEA 113	Marine Geophysics	3
OCEA 114	Chemical Oceanography	3
OCEA 115	Geological Oceanography	3
GEOL 125	Marine Geology	3
GEOL 181–2	Oceanography I and II	3–3
GEOP 105	Elementary Geophysics	3
GEOP 107	Land Forms (Geomorphology)	3
GEOP 115	Elementary Seismology	3
GEOP 205	Advanced Geophysics	3
GEOP 215	Advanced Seismology	3

The instructional staff for the courses listed above consists of the following:

- Orlin, Hyman, Ph.D., Program Adviser and Professorial Lecturer
- Algermissen, Sylvester T., Ph.D., Associate Professorial Lecturer
- Anderson, Neil R., Ph.D., Assistant Professorial Lecturer
- Buzas, Martin A., Ph.D., Associate Professorial Lecturer
- Espinosa, Alvaro F., M.S., Assistant Professorial Lecturer
- Hicks, Steacy D., M.S., Associate Professorial Lecturer
- Maloney, William E., M.S., Associate Professorial Lecturer
- Morrison, Robert E., Ph.D., Assistant Professorial Lecturer
- Pierce, Jack W., Ph.D., Adjunct Professor of Geology
- Rinehart, Wilbur A., M.S., Lecturer
- Rucker, James B., Ph.D., Assistant Professorial Lecturer

To obtain further information, address all inquiries directly to:

Director of Credit Programs
College of General Studies
The George Washington University
706 20th Street, N. W.
Washington, D. C. 20006

UNIVERSITY OF GEORGIA
Athens, Georgia

Modern graduate training and research facilities in marine sciences are available on the Athens campus and at the University's Marine Institute on Sapelo Island, Georgia. In addition, staff and graduate students participate in studies utilizing federally supported ships and other facilities not owned by the University.

Facilities for training and research in the marine sciences at Athens include classrooms and laboratories in all participating departments. At Sapelo Island, modern, well-equipped laboratories occupy more than 10,000 square feet of space. Living accommodations on the Island include family housing units for staff and dormitory space for eighteen. The principal research vessel of the Institute is 65 feet in length and is equipped to carry out investigations on the continental shelf and slope as well as in the estuaries. A fleet of smaller boats is maintained for work in the extensive estuaries and salt marshes of the area. Research at the Institute has centered mainly in the ecology of marshes and estuaries, aquaculture, estuarine pollution, the geochemistry of estuaries and shelf waters, and the geology of the barrier islands and pleistocene shelf deposits.

The University offers the **M.S. and Ph.D. degrees with emphasis on marine science** in four basic science departments; Botany, Geology, Microbiology and Zoology. No degrees specifically designated as marine science or oceanography are offered. Specific degree requirements very slightly among the departments, but, in general, 40 credit hours of formal course work, a thesis and a reading knowledge of one foreign language, as well as satisfactory performance on a comprehensive examination in the basic science field involved, are required for the M.S. degree. Formal course requirements for the Ph.D. are flexible, the program being determined by the student in consultaton with his advisory committee. Preliminary written and oral examinations and a final oral examintion are administered by the department. A reading knowledge of a second foreign language and a dissertation are also required for the Ph.D.

Courses pertinent to graduate training in the biological and physical aspects of marine science are offered in the Division of Physical Sciences and Division of Biological Sciences in the College of Arts and Sciences and in the School of Forest Resources. In the college of Arts and Sciences the departments which grant graduate degrees with marine science specialization are: Botany, Microbiology, Zoology and Geology.

Advanced courses that are wholly or partly marine in aspect are listed by department. Courses number 800 or above are strictly graduate, others are senior-graduate. All are based on the Athens campus but may involve trips to the field and to other facilities. Credits are in quarter hours.

Department of Botany		
610	Growth and Development of Algae	5
860	Aquatic Plants	5
School of Forest Resources		
767	Marine Fisheries	5
Department of Geography		
601	Advanced Climatology	5
602	North American Physiography	5
620	Use and Interpretation of Aerial Photographs	5
622	Advanced Photogrammetry Laboratory	5
Department of Geology		
603	Invertebrate Paleontology	5
605	Sedimentation and Stratigraphy	5
608	Optical Mineralogy	5
609	Marine Geology	5
610	Sedimentary Petrology	3
611	Principles of Geochemistry	3
612	Palynology	5
613	Paleobotany	5

Department of Geology–*Continued*

630	Clay Mineralogy	5
639	Introduction to Geophysics	5
805	Advanced Stratigraphy	3
811	Petrography and Petrology of Sedimentary Rocks	3
815	Special Problems in Sedimentology and Oceanography	5
820	Geotectonics	3

Department of Microbiology

662	Aspects of Microbial Ecology	5
860	Physiology of Bacteria	5

Department of Zoology

600	Bioenergetics and Ecosystems	5
605	Ichthyology	5
660	Marine Ecology	5
807	Advanced Invertebrate Zoology	5
808	Advanced Invertebrate Zoology	5
810	Limnology and Oceanography	5
811	Marine Biology	5
812	Freshwater Biology	5
813	Hydrobiology Seminar	1
854	Physiological Ecology	5
855	Population Ecology	5
856	Ecology Seminar	1
857	Pollution Ecology	5
858	Systems Ecology I	3
859	Systems Ecology II	3

The instructional staff for the courses listed above consists of the following:

University of Georgia Marine Institute

Henry, Vernon J., Ph.D., Director and Associate Professor of Geology
Dahlberg, Michael D., Ph.D., Assistant Professor of Zoology
Greene, Albert G., Ph.D., Assistant Director
Howard, James D., Ph.D., Assistant Professor of Geology
Hoyt, John H., Ph.D., Associate Professor of Geology
Marland, Frederick C., Ph.D., Research Associate in Zoology
Reimold, Robert J., Ph.D., Research Associate in Zoology

Department of Botany

Fuller, Melvin S., Ph.D., Head and Professor of Botany
Duncan, Wilbur H., Ph.D., Professor of Botany
Kochert, Gary, Ph.D., Assistant Professor of Botany

School of Forest Resources

Huish, Melvin T., Ph.D., Assistant Professor of Fisheries
Fox, Alfred C., Ph.D., Unit Leader, Coop. Fishery Unit, USFWS and Assistant Professor of Fisheries

Department of Geology

Hurst, Vernon J., Ph.D., Head and Professor of Geology
Allard, Gilles O., Ph.D., Associate Professor of Geology
Brown, Anton, Ph.D., Assistant Professor of Geology
Carver, Robert E., Ph.D., Assistant Professor of Geology
Noakes, John E., Ph.D., Associate Professor of Geology
Rich, Mark, Ph.D., Associate Professor of Geology
Stanley, Edward A., Ph.D., Associate Professor of Geology
Voorhies, Michael R., Ph.D., Assistant Professor of Geology
Wiedemann, Hartmut, Ph.D., Assistant Professor of Geology

Department of Microbiology

- Payne, William J., Ph.D., Head and Professor of Microbiology
- Eagon, Robert G., Ph.D., Professor of Microbiology
- Wiebe, William J., Ph.D., Assistant Professor of Microbiology

Department of Zoology

- Frankenberg, Dirk, Ph.D., Associate Professor of Zoology
- Johannes, Robert E., Ph.D., Associate Professor of Zoology
- Odum, Eugene P., Ph.D., Alumni Foundation Distinguished Professor of Zoology
- Patten, Bernard C., Ph.D., Professor of Zoology
- Pomeroy, Lawrence R., Ph.D., Professor of Zoology
- Scott, Donald C., Ph.D., Chairman, Division of Biological Sciences and Professor of Zoology
- Thomas, Grace J., Ph.D., Associate Professor of Zoology

To obtain further information, address all inquiries directly to:

Dr. E. L. Cheatum, Director
Institute of Natural Resources & Coastal Development
Graduate Studies Research Center
University of Georgia
Athens, Georgia 30601

UNIVERSITY OF GUAM
Agana, Guam

The University's marine sciences facilities are located on the main campus. The 25,000 square-foot science building holds the laboratories and office of the Division of Biosciences and Marine Studies. A marine biological research laboratory is to begin construction in early summer, 1969. The University has a small eighteen foot fiberglass research vessel, M.V. ALU. Sea-water analytical equipment is available. "Micronesica", Journal of the University of Guam, presently in its fourth volume, publishes articles pertaining to the sciences of the Pacific, particularly the Micronesian area.

The University offers the degree of **Master of Science in Biology** through its Division of Biosciences and Marine Studies. Although the University's biology program is not specifically designed as a marine science-oriented program, the majority of students at the University work with some aspect of marine studies. A total of thirty semester hours is required. Each student must take a Biological Literature and Manuscripts seminar, and at least one biological seminar is required each year while in residence. The remainder of twenty-four semester hours is in course work. A thesis is required of all students. Special problems or directed research is also allowed.

The following courses are offered in conjunction with the above program:

BI 333	Oceanology	3
BI 545	Marine Biogeography	2
BI 580	Marine Ecology	4
BO 420	Marine Botany	4
ZO 441	Ichthyology	4
ZO 532	Marine Invertebrate	4

The instructional staff for the courses listed above consists of the following:

Division of Biosciences and Marine Studies

Eldredge, L. G., Ph.D., Chairman and Professor of Biology
Adair, Charles N., Ph.D., Associate Professor of Biology
Chesher, Richard A., Ph.D., Associate Professor of Biology
Davis, Donald M., Ph.D., Associate Professor of Biology
Jones, Robert S., Ph.D., Associate Professor of Biology
Tsuda, R. T., M.S., Assistant Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Lucius G. Eldredge
Chairman, Division of Biosciences and Marine Studies
University of Guam
Agana, Guam 96910

UNIVERSITY OF HAWAII
Honolulu, Hawaii

The laboratory and classroom facilities of the Department of Oceanography are located in the Hawaii Institute of Geophysics on the Manoa campus of the University of Hawaii. In the same building and available for use by the Department are the Geophysics Library and the Statistical and Computing Center containing IBM 1401 and 360 computers.

The Department is closely associated with the Hawaii Institute of Geophysics, a geophysical research institute that, in cooperation with various departments, provides research facilities and appointments in astrophysics, geochemistry, geology, meteorology, oceanography, and geophysics. The Institute also maintains a high-altitude observatory on the summit of Mount Haleakala, Maui, and a seismic vault in upper Manoa Valley.

Other facilities that are available to the Oceanography Department are the Hawaii Marine Laboratory, an ocean-side laboratory on the east coast of Oahu devoted to advanced training, research, and instruction in marine biology; Gregg M. Sinclair Library; the new graduate library and the Honolulu Biological Laboratory of the U. S. Fish and Wildlife Service, a major oceanographic biological research institute located on the University campus.

The marine facilities of the Department are located at Pier 18, Honolulu, a ten minute drive from the University. These include storage buildings, repair shops and docking facilities for the University's research vessel, TERITU, and the various smaller boats used for nearshore research. The TERITU is a 90-foot steel-hulled research vessel converted and over-hauled in 1964 and equipped with the latest oceanographic equipment. She has approximately 480 square feet of electronic and wet laboratory space and well-furnished quarters for six scientists. Smaller boats include a 46-foot decked boat, the SALPA. Two larger research vessels belonging to the U. S. Fish and Wildlife Service are available for use in cooperation with that agency's research program: the GILBERT, 122 feet, and the newly constructed CROMWELL, 158 feet.

The following degrees are offered by the University by the Departments indicated.

1. **Ph.D. in Oceanography (Department of Oceanography).** All students are required to obtain practical research experience in oceanography, to pass a departmental examination and to satisfactorily demonstrate ability to carry out independent research. Although there are no absolute course requirements, the departmental examination will deal with subjects normally covered in Oceanography 620, 621, 622, and 623. Following the satisfactory completion of the examination, the student will normally begin a thesis project. Within a year he takes his University comprehensive, and then completes his thesis. Each student must also display a reading knowledge of one foreign language (German, French, Russian, Spanish, or Japanese). Computer competence is also required.

2. **M.S. in Oceanography (Department of Oceanography).** All students are required to obtain practical field experience in oceanography and to demonstrate competence in oceanography by satisfactorily completing a departmental examination and a thesis project. Each student is required to satisfactorily complete 24 credit hours of graduate level courses which must include Oceanography 620, 621, 622, 623 and a seminar. Computer competence is also required.

3. **M.S. in Botany, Ph.D. in Botany (Department of Botany).** Work required to remedy deficiencies and for degree programs will be decided through a diagnostic examination at the time of enrollment in the department and by continuing faculty counseling. Thesis work may be undertaken in four broad areas: environmental botany; physiology and biochemistry; structure and development; and systematics and evolution. Appropriate organisms for research may be selected from the algae, fungi, ferns, or flowering plants, representing tropical, marine or economic plants.

4. **M.S. in Geosciences, Ph.D. in Geosciences (Department of Geosciences).** Degree candidates must satisfactorily complete a minimum of 18 credit hours of course work and 12 credit hours of thesis research, as well as a demonstrate a reading knowledge of one foreign language with useful scientific literature in the field of the candidate.

Geology. Entering students not having year-length courses in elementary geology, physics, chemistry, college mathematics, and geological field methods, and at least one semester of mineralogy, petrology, and structural geology or their equivalent will be obliged to take those courses. Both the M.S. and Ph.D. examinations may include questions from all of the basic fields of geology, such as mineralogy, petrology, structural geology, stratigraphy, geomorphology, and paleontology.

Solid Earth Geophysics. It is desirable that intended candidates possess undergraduate training equivalent to 20 credit hours in each of mathematics, physics, and geology. Besides geosciences courses, courses may be allowed in engineering, physics, mathematics, and chemistry. Experience with an exploration or research organization will prove beneficial for Ph.D. candidates.

5. **M.S. in Microbiology (Department of Microbiology).** The department offers programs leading to the M.S. in microbiology with areas of specialization in microbial biochemistry, genetics, and ultrastructure; the biology of infectious diseases; the biochemistry and genetics of viruses; immunology and immunochemistry; marine microbiology and developmental and cell biology. Studies in microbiology emphasize fundamental biological, biochemical, and physical-chemical approaches and not those primarily of an applied or diagnostic nature.

Intended candidates should have adequate undergraduate preparation in both biological and physical sciences, including microbiology, a basic course in either biology, botany or zoology and courses in organic chemistry, biochemistry, calculus, physics. Official scores of the Graduate Record Examination and three letters of recommendation are required of all applicants. Courses for the graduate program are to be selected from those offered in the related fields of biochemistry, biophysics, botany, chemistry, genetics, mathematics, oceanography, public health, and zoology.

6. **Ph.D. in Microbiology (Department of Microbiology).** The department offers programs leading to the Ph.D. in microbiology with areas of specialization in microbial biochemistry, genetics, and ultrastructure; the biology of infectious diseases; the biochemistry and genetics of viruses; immunology and immunochemistry; marine microbiology and developmental and cell biology. Studies in microbiology emphasize fundamental biological, biochemical, and physical-chemical approaches and not those primarily of an applied or diagnostic nature.

Intended candidates should have adequate undergraduate preparation in both biological and physical sciences, including microbiology, a basic course in either biology, botany, or zoology, and courses in organic chemistry, biochemistry, calculus, and physics. Intended Ph.D. candidates are urged to complete a course in physical chemistry. Deficiencies in undergraduate preparation can be made up in graduate study. Official scores of the Graduate Record Examination and three letters of recommendation are required of all applicants.

Courses for the graduate program are to be selected from the microbiology course offerings and from others offered in the related fields of biochemistry, biophysics, botany, chemistry, genetics, mathematics, oceanography, public health, and zoology. Microbiology 690 and 699 are required.

7. **M.S. in Zoology (Department of Zoology).** Intended candidates for the M.S. in zoology must present a minimum of 18 hours of undergraduate preparation in zoology, including courses in vertebrate zoology (including comparative anatomy), embryology, and physiology. They should have completed two years of chemistry (inorganic and organic), and courses in calculus, botany, and one year of physics. Deficiencies in undergraduate preparation must be made up. An official record of the student's performance on the Graduate Record Examination (Aptitude Test and the Advanced Test in Biology) must be submitted to the chairman of the zoology department. One seminar each year is required. For the M.S. program under Plan A a maximum of 6 hours, and under Plan B a minimum of 6 hours, may be elected from related courses in botany, chemistry, entomology, genetics, mathematics, meteorology, oceanography, and physics.

8. **Ph.D. in Zoology (Department of Zoology).** Intended candidates for the Ph.D. in zoology must present a minimum of 18 hours of undergraduate preparation in zoology, including courses in vertebrate zoology (including comparative anatomy), embryology, and physiology. The student should have completed two years of chemistry (inorganic and organic), and courses in calculus, botany, and one year of physics. Deficiencies in undergraduate preparation must be made up. An official record of the student's performance on the Graduate Record Examination (Aptitude Test and the Advanced Test in Biology) must be submitted to the chairman of the zoology department. One seminar each year is required. Zoology 702 and 800 are required for Ph.D. candidates. Additional work will be stipulated by the supervising committee. Candidates must pass a reading examination in one foreign language.

The following courses are offered in conjunction with the above programs:

Oceanography		
201	Science of the Sea	3
620	Physical Oceanography	3
621	Biological Oceanography	3
622	Geological Oceanography	3
623	Chemical Oceanography	2
632	Littoral Geological Processes	3
633	Chemical Oceanography Laboratory Methods	2
636	Phytoplankton Ecology	2
640	Advanced Physical Oceanography	3
642	Recent Marine Sediments	3
643	Marine Geochemistry	3
644	Marine Geological and Geophysical Techniques	3
646	Zooplankton Ecology	2
647	Zooplankton Ecology Laboratory	2
660	Ocean Wave Theory	3
661	Tides	3
662	Marine Hydrodynamics	3
663	Measurements and Instrumentation	2
672	Ocean Basins	3
673	Continental Shelves	3
701	Nekton Ecology	2
735	Seminar in Oceanography	2
750	Topics in Biological Oceanography	2
760	Topics in Physical Oceanography	2
770	Seminar in Chemical Oceanography	1
Botany		
480	Phycology	3
651	Dynamics of Marine Productivity	3
631	Marine Phytoplankton	3
681–684	Advanced Phycology	2
Geosciences		
320	Marine Geology	3
661	Marine Geophysics	3
Microbiology		
480	Microbial Ecology	4
Zoology		
620	Marine Ecology	3
629	Methods of Fisheries Investigation	3
716	Topics in Fish and Fisheries Biology	3

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Oceanography

Murphy, Garth I., Ph.D., Chairman and Professor of Oceanography
Andrews, James E., Ph.D., Assistant Professor of Oceanography
Brock, Vernon E., M.A., Professor of Oceanography
Caperon, John, Ph.D., Associate Professor of Oceanography
Cattell, Allen S., Ph.D., Assistant Professor of Oceanography
Chave, Keith E., Ph.D., Professor of Oceanography
Clarke, Thomas A., Ph.D., Assistant Professor of Oceanography
Clutter, Robert I., Ph.D., Associate Professor of Oceanography

Department of Oceanography—*Continued*

Gallagher, Brent, Ph.D., Assistant Professor of Oceanography
Gordon, Donald C., Ph.D., Assistant Professor of Oceanography
Graefe, Volker, Ph.D., Assistant Geophysicist
Groves, Gordon W., Ph.D., Professor of Oceanography
Malahoff, Alexander, Ph.D., Assistant Geophysicist
Roy, Kenneth, Ph.D., Assistant Professor of Oceanography
Stroup, Edward D., M.A., Associate Oceanographer
Wyrtki, Klaus, Ph.D., Professor of Oceanography

Department of Botany

Doty, Maxwell, Ph.D., Professor of Botany

Department of Geosciences

Sutton, George H., Ph.D., Professor of Geosciences
Moberly, Ralph, Jr., Ph.D., Associate Professor of Geosciences
Ramage, Colin S., Sc.D., Professor and Chairman of Geosciences

Department of Microbiology

Gundersen, Kaare,R., Ph.D., Associate Professor of Microbiology

Department of Zoology

Ebert, Thomas A., Ph.D., Assistant Professor of Zoology
Banner, Albert H., Ph.D., Professor of Zoology
Reese, Ernst S., Associate Professor, Zoology

To obtain further information, address all inquiries directly to:

Dean Wytze Gorter
Graduate Division
University of Hawaii
Honolulu, Hawaii 96822

Dr. Garth I. Murphy, Chairman
Department of Oceanography
University of Hawaii
Honolulu, Hawaii 96822

HUMBOLDT STATE COLLEGE
Arcata, California

The marine science programs at Humboldt State College offer instruction and opportunities for research in marine fisheries, oceanography, and the marine aspects of zoology, botany and ecology. Present facilities include saltwater aquaria, a water chemistry laboratory, ichthyology laboratories, and zoology and botany classrooms and laboratories. A 40-foot research vessel equipped with standard oceanographic and biological instrumentation is available. A marine sciences laboratory with a modern saltwater system is located at Trinidad, California.

The College offers the following degrees through the Divisions indicated:

Division of Natural Resources

1. Bachelor of Science in Oceanography

a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.

b. Lower division requirements: Math 5 ABC, Physics 4 ABCD, Geol. 1, Chem. 20 ABC, Biol. 3, Zool. 1, Bot. 1, Biol. 40 or Math 25.

c. Upper division requirements: Chem 101, Chem 102, Ocn 100, Ocn 101, Ocn 102, Ocn 103 AB, Ocn 106, Ocn 180, Ocn 190, Ocn 199.

d. 25 Units of approved science courses.

e. Free electives to bring total units for the B.S. Degree to 192 quarter units.

Division of Biological Sciences

2. Bachelor of Arts in Biology

a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.

b. Lower division requirements: Biology 3, Botany 1, Zoology 1, Chemistry 10A-10B, Physics 15A-15B.

c. Upper division requirements: Biology 114, 119; Chemistry 128.

d. Completion of one of the following options:

Biology option: Biology 107; Botany 110, 120; Zoology 101 or Botany 101; Zoology 112, Zoology 114 or 116; Mathematics 8 units beyond Math C and including Nat Res 40 as an alternative.

Medical Technology option: Biology 103, 120, 124; Botany 130; Zoology 101, 120, 121, 166, 174; Chemistry 11, 101, 102.

e. Free electives to bring total units for the A.B. degree to 186. Sixty of the total units must be upper division, 36 of which must be in approved upper division science courses.

3. Master of Arts in Biology

The following requirements are prescribed for the degree of Master of Arts in Biology:

a. Completion of 45 upper division or graduate units in biology or supporting courses approved by the graduate committee including a minimum of 18 units of graduate courses.

b. Oral preliminary examination by graduate committee to be taken prior to registration of the last 30 units. The purpose of this examination is to establish the candidate's deficiencies and required courses. No one fails this examination; however, the candidate may be asked to repeat the examination and a poor showing may necessitate repetition of lower division and undergraduate courses without credit.

c. Completion of a total of not less than 8 units or more than 10 units of 290 and 299 and a thesis approved by the graduate committee:

–OR–

A special problem to be completed concurrently in enrollment of a total of 4 units of 290 and 299. Students electing to do a special problem rather than a thesis may not apply more than 4 units of 125, 19, 290 or 299 toward the 45 required units.

d. A final oral examination by the graduate committee. This will include a defense of the thesis for students electing to write a thesis.

4. Bachelor of Arts in Botany

a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.

b. Lower division requirements: Biol, 3, Bot. 1, Chem. 10A-10B, Physics 15A-15B, Zool. 1, Math 15A-15B.

c. Upper division requirements: Biol. 114; Bot. 101, 110, 121, 122, 126, 130, 140 or 145, 150-151 (or Biol. 107), Biol. 125 or 129; Chem. 128, one course in zoology or physiology (3-5 units).

d. Free electives to bring total units for the A.B. degree to 186. Sixty of the total units must be upper division.

5. Bachelor of Arts in Zoology

a. General education: Required and elective courses to insure cultural breadth in the humanities, social sciences, and English and speech.

b. Lower division requirements: Biol. 3, Bot. 1, Chem. 10A-10B, Physics 15A-15B, Zool. 1, Math. 15A-15B.

c. Upper division requirements: Biol. 107, 114; Zool. 101, 112, 114 or 116, 143, 160; Chem. 128; one Botany course (3-5 units).

d. Free electives to bring total units for A.B. degree to 186. Sixty of the total units must be upper division.

The following courses are offered on conjunction with the above programs (credits are in quarter hours):

Courses in Oceanography:

Upper Division Undergraduate Courses

100	General Oceanography	5
101	Biological Oceanography	4
102	Physical Oceanography	4
103A, 103B	Chemical Oceanography	3–3
105	Methods and Instruments of Oceanography	2
106	Geological Oceanography	3
112	Advanced Physical Oceanography	3
116	Marine Sedimentation	4
121	Zooplankton Ecology	4
125	Field Problems	1–3
126	Beach and Nearshore Processes	3
131	Marine Radioecology	3
180	Undergraduate Seminar	1
181	Seminar in Biological Oceanography	1
182	Seminar in Physical Oceanography	1
183	Seminar in Chemical Oceanography	1
186	Seminar in Geological Oceanography	1
190	Field Cruise	1
199	Independent Study	1–3

Division of Biological Sciences:

Courses in Biology:

Upper Division Undergraduate Courses

141	Marine Biology	4

Courses in Botany:

Upper Division Undergraduate Courses

145	Marine Phycology	4

Graduate Courses

231	Marine Mycology	4
245	Physiological Ecology of Seaweeds	4

Courses in Zoology:

Upper Division Undergraduate Courses

112	Invertebrate Zoology	5
142	Ecology of Marine Animals	4
143	Invertebrate Physiology	4

Graduate Courses

212	Advanced Invertebrate Zoology	4
242	Benthic Ecology	3
244	Invertebrate Embryology	4

The University also offers an undergraduate program in fisheries which is described in the Fisheries section of this publication.

The instructional staff for the courses listed above consists of the following:

Division of Biological Sciences

Allen, William V., Ph.D., Assistant Professor of Zoology
Beilfuss, Erwin, Ph.D., Professor of Zoology
Brusca, Gary, Ph. D., Assistant Professor of Biology
DeMartini, John D., Ph.D., Associate Professor of Biology
Houck, Warren J., Ph.D., Professor of Zoology
Rasmussen, Robert A., Ph.D., Assistant Professor of Botany
Waters, James, Ph.D., Assistant Professor of Zoology

Division of Natural Resources

Crandell, George F., Ph.D., Assistant Professor of Oceanography
Gast, James A., Ph.D., Associate Professor and Coordinator of Oceanography, Director of Marine Laboratory
Reinert, Richard L., B.S., Assistant Professor of Oceanography
Thompson, Robert W., Ph.D., Assistant Professor of Oceanography

To obtain further information, address all inquiries directly to:

Dr. James A. Gast
Director, Marine Laboratory
Humboldt State College
Arcata, California 95521

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THE JOHNS HOPKINS UNIVERSITY
Baltimore, Maryland

Macaulay Hall, on the Homewood Campus of the University, offers adequate office, laboratory and shop space for all branches of the oceanographic program. Other experimental facilities are available in Maryland and Latrobe Halls. The laboratories are well equipped with the general and specialized equipment required for oceanographic research. Photographic, drafting and data reduction facilities are available to students; an extensive and active Computing Center is maintained on campus.

In addition, the resources of the Chesapeake Bay Institute, a division of the University engaged in oceanographic contract research, are available to students in the Department of Earth and Planetary Sciences. The C.B.I. research vessels are docked at the Institute's field laboratory at Annapolis, about an hour's drive from the compus. The 106-foot catamaran R/V RIDGELY WARFIELD is the largest of the Institute's vessels, specifically designed for research in estuarine and coastal waters. The 70-foot R/V MAURY and several smaller vessels are included in the fleet. A large barge is available for long term, on-station studies. Included in the Institute is an engineering design group for the development of new oceanographic instruments.

The Department of Earth and Planetary Sciences has an agreement with the Smithsonian Institution in Washington, D. C., which permits students to use their facilities should this be required for their research.

The Department will accept candidates for either a **M.A. or Ph.D.** program. Candidates for the M.A. in Oceanography must complete a prescribed program of course work in Oceanography, demonstrate a reading knowledge of French, German or Russian, complete an essay based on original work, and pass an oral examination before a committee of the Department.

Candidates for the Ph.D. will take such courses and meet such requirements as deemed necessary by their advisory committee, must satisfy the foreign language requirements of the Department, must pass a comprehensive written examination prepared by an appropriate Departmental committee and pass the oral examination administered by the Graduate Board of the University, and submit an acceptable dissertation based on original research. A year of residence at the University is required for all advanced degrees.

The following courses in the marine sciences are offered during the regular year at the main campus by the Department of Earth and Planetary Sciences.

27.11-12	Introduction to the Earth Sciences	3
27.301-302	Problems in the Earth Sciences	4½
27.314	Marine Geology	5½
27.331-332	Marine Ecology	4½
27.603	Advanced Theoretical Oceanography	4½
27.605-606	Waves and Tides	4½
27.611-612	Physical Oceanography	5
27.615	Research Problems in Oceanography	
27.616	Biological Oceanography	4½
27.620	Advanced Biological Oceanography	3½
27.623	Marine Microbiology	
27.624	Chemistry of Sea Water	4½
27.625	Advanced Chemical Oceanography	4½
27.626	Estuarine Oceanography	3
27.628	Advanced Wind Wave Theory	3
27.630	Oceanic Turbulence	3
27.678	Carbonates	5½
50.311-12	Introduction to Meteorology	4½
50.659-660	Turbulence	4½

The instructional staff for the courses listed above consists of the following:

Oceanography

- Phillips, Owen M., Ph.D., Chairman and Professor of Geophysics
- Bricker, Owen P., Ph.D., Assistant Professor of Geology
- Carpenter, James H., Ph.D., Associate Professor of Oceanography
- Eugster, Hans P., D.Sc., Professor of Geology
- Ginsburg, Robert N., Ph.D., Professor of Geology & Oceanography
- Hardie, Lawrence A., Ph.D., Assistant Professor of Geology
- Kinsman, Blair, Ph.D., Associate Professor of Oceanography
- Long, Robert R., Ph.D., Professor of Fluid Mechanics
- Marcus, Allan, Ph.D., Associate Professor of Statistics and Earth & Planetary Sciences
- Montgomery, Raymond B., Sc.D., Professor of Oceanography
- Pettijohn, Francis J., Ph.D., Professor of Geology
- Pritchard, Donald W., Ph.D., Professor of Oceanography
- Taylor, W. Rowland, Ph.D., Associate Professor of Oceanography
- Watson, Geoffrey S., Ph.D., Professor of Mathematical Statistics
- Wilson, Simon D. R., Ph.D., Visiting Assistant Professor in Meteorology

To obtain further information, address all inquiries directly to:

Dr. Owen M. Phillips, Chairman
Dept. of Earth and Planetary Sciences
The Johns Hopkins University
Baltimore, Maryland 21218

LEHIGH UNIVERSITY
Bethlehem, Pennsylvania

The University offers marine science and ocean engineering courses on its main campus at Bethlehem, Pa. The Center for Marine and Environmental Studies (CMES), located in Williams Hall on the main campus, is a faculty and graduate research organization, encouraging interdisciplinary research in ocean engineering, marine science and environmental studies. CMES is interdepartmental, and provides opportunities for staff and students from the fields of biology, geology, chemistry and physics, and civil, mechanical and chemical engineering to carry out research on problems of common interest.

The facilities of CMES include: a well-equipped laboratory for microbiological and biochemical research; a laboratory with several circulating temperature-controlled artificial saltwater aquaria; and a well-equipped facility for geotechnical ocean engineering research, including telemetering probes for measuring significant engineering properties of bottom sediments in water depths to 4.5 kms, advanced-design sediment corers, a fine-focus X-ray machine, a gamma-ray transmission densitometer, and a walk-in core refrigerator.

The University Computing Center (CDC-6400 and peripheral equipment) is available for staff and students. Some major items of equipment shared with other departments include: an Applied Research Laboratory electron microprobe, an RCA electron microscope, Norelco X-ray diffractometer, Beckman DU spectrophotometer, Beckman infrared analyzer and carbon train, Coleman nitrogen analyzer, and the facilities of Hydraulics Division of Fritz Laboratory with a variety of flumes, wave tanks, and sedimentation tanks and tables.

Most of the work at sea is done through cooperative programs with Bermuda Biological Station, Duke University, Woods Hole Oceanographic Institution, the Sandy Hook Laboratory of the U. S. Bureau of Fish and Wildlife, the Atlantic Oceanographic Laboratories of ESSA in Miami, and Texas A&M University.

Lehigh is an active member of The Institute for Development of Riverine and Estuarine Systems (IDRES), and maintains the R/V MYSID, a 20-foot shallow draft catamaran for riverine and estuarine research.

The M.S. and Ph.D. degrees are awarded in chemistry, biology, and geology. Graduate options or minors are available in Marine Science, Ocean Engineering, and Water Pollution Control. These and other interdisciplinary programs can be arranged.

General Requirements

Master's Degrees—All students complete satisfactorily at least two full semesters of advanced work. The minimum program for the master's degree must include:

a. Not less than thirty semester hours of graduate work.
b. Not less than eighteen hours of "400" level course work.
c. Not less than eighteen hours in the major field.
d. Not less than fifteen hours of "400" courses in the major field.

The eighteen hours required in the major field are ordinarily taken in one department. The remaining twelve hours of a minimum program, or any part of them, may also be taken in the major department; or they may be taken in any other field in which courses for graduate credit are offered subject to the approval of the chairman of the major department. In order to qualify for the master's degree, candidates will be required (a) to submit a thesis or a report based on a research course of at least 3 credit hours, and/or (b) to pass a comprehensive examination given by the major department. If required, the thesis shall not count for more than six semester hours.

The master's degree is not granted unless the candidate has earned the grades "A" or "B" in at least eighteen hours of the work of his program. No course in which the grade is earned is less than "C" is credited toward the degree. When all requirements have been met, the candidate is recommended by the faculty to the trustees for the master's degree appropriate to the work pursued.

Doctor of Philosophy—The degree of Doctor of Philosophy is conferred on candidates who have demonstrated general proficiency and high attainment in a special field of knowledge and capacity to carry on independent investigation in that field as evidenced by the presentation of an acceptable dissertation embodying the results of original research.

A candidate ordinarily is expected to devote three or more academic years to graduate study. Graduate work done in residence at other institutions may be accepted in partial fulfillment of the time requirements. A candidate for the degree must complete at least one full academic year or resident graduate study at Lehigh University.

The student and his faculty advisor are expected to initiate steps for approval of the student's program in the first semester following completion of 30 hours of graduate credit. The department will determine by examinations or other credentials whether the student is qualified.

At the time of application for program approval a special committee is appointed by the Graduate Committee to direct the work of the candidate.

Preparation for the degree is based on the study of a major subject to which one or two minors may be added. The program of work, to be formulated by the candidate, his special committee, and the chairman of his major department, should be planned to lead to a general mastery of the major field and to a significant grasp of any minor that may be added.

The candidate must give evidence, through examinations, of a reading knowledge, sufficient for the purposes of his special studies, of at least two foreign languages. In each case, the required languages are designated by the candidate's major department and approved by the Graduate Committee. In certain fields, the candidate with permission may reduce the requirement to one language appropriate to his field. The qualifying examination in one language must be passed at least twelve (12) months before the candidate applies for his degree.

The general examinations for the doctorate are designed to test both the student's capacity and his proficiency in his field of study and may be both oral and written. They are held not later than seven months prior to the time when the candidate plans to receive the degree.

The candidate is required to present a dissertation prepared under the general direction of a professor at Lehigh University. The dissertation shall treat a topic related to the candidate's major subject, embody the results of original research, give evidence of high scholarship, and constitute a contribution to knowledge. It must be approved by the professor under whose direction it was written, by the candidate's special committee, and by the Graduate Committee.

After the dissertation has been accepted by his special committee, the candidate will be examined orally by the officers of professorial rank in the departments concerned and such other persons as may be selected by the candidate's special committee.

In cooperation with the Center for Marine and Environmental Studies (not an academic department), the Departments of Geological Sciences, Biology, Chemistry, Physics, Civil Engineering, Mechanical Engineering and Mechanics, and Chemical Engineering offer courses during the academic year at the Lehigh campus. Special workshop and practical oceanography courses are offered during the spring in cooperation with the Bermuda Biological Station.

Biol. 417	Marine Ecology	F	3
Biol. 418	Biological Oceanography	F	3
Biol. 480	Marine Science Seminar	Sp	1
C. E. 328	Channel and Oceanographic Hydraulics	Sp	3
C. E. 332	Ocean Engineering	Sp	3
C. E. 425	Mechanics of Sediment Transport	F	3
C. E. 4xx	Marine Geotechnique	Sp*	3
Geol. 363	Introduction to Oceanography	Sp	3
Geol. 461	Marine Geology	Sp	3

The instructional staff for the courses listed above consists of the following:

Department of Geological Sciences

Parks, James M., Ph.D., Director Center for Marine and Environmental Studies and Associate Professor of Geology

MacNamara, E. Everett, Ph.D., Assistant Professor of Geology

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*Offered in alternate years.

Department of Geological Sciences–*Continued*

Richards, Adrian F., Ph.D., Professor of Oceanography and Ocean Engineering
Ryan, J. Donald, Ph.D., Professor of Geology
Schopf, Thomas J. M., Ph.D., Assistant Professor of Geology

Department of Biology

Barber, Saul B., Ph.D., Professor of Biology
Herman, Sidney S., Ph.D., Associate Professor of Biology (at Sandy Hook Marine Laboratory)
Pearce, Jack B., Ph.D., Adjunct Assistant Professor of Biology

Department of Chemistry

Diefenderfer, A. James, Ph.D., Associate Professor of Chemistry
Merkel, Joseph R., Ph.D., Professor of Biochemistry

Department of Chemical Engineering

Coughlin, Robert W., Ph.D., Associate Director CMES, and Professor of Chemical Engineering

Department of Civil Engineering

Adams, John R., Ph.D., Assistant Professor Civil Engineering
Graf, Walter H., Ph.D., Associate Professor Civil Engineering
Richards, Adrian F., Ph.D., Professor of Oceanography and Ocean Engineering

Department of Mechanical Engineering and Mechanics

Stenning, Alan H., Sc.D., Professor of Mechanical Engineering
Terry, Theodore A., Ph.D., Assistant Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Dr. James M. Parks, Director
Center for Marine and Environmental Studies (CMES)
Lehigh University
Bethlehem, Pennsylvania 18015

LONG ISLAND UNIVERSITY (MITCHEL CAMPUS)
East Meadow, New York

The graduate department of marine science consists of three groups: (1) Marine biology, with concentration in marine microbiology, marine biochemistry, and ichthyology, (2) Geophysical sciences, with concentration in physical oceanography and sedimentation, and (3) Technology, with concentration in ocean engineering and instrumentation. Facilities are now located at the Mitchel Center (a branch of C.W. Post-Merriweather Campus) with 26,000 sq. ft. of teaching and research space, and at the Southampton Campus where there is a seaside marina and marine biology laboratory. The Graduate Department operates a 56-foot ocean going motor sailer, the LUCAYO; a 28-foot inshore boat, the ELDON; and several small craft and aircraft. In addition, there is a mobile field laboratory for inshore ecological work.

The University offers the degree of **Master of Science in Marine Science**. Students may specialize in biology, geophysical sciences, or technology.

The following courses are offered in conjunction with this program by the Department of Marine Science:

MC 501	Marine Biology	Sp	3
MC 502	Marine Biology	Su	3
MC 608, 609	Marine Ecology	Sp, Su	3, 3
MC 610, 611	Marine Microbiology		3, 3
MC 615	Behavior of Marine Organisms	F	3
MC 616	Behavior of Marine Organisms	Sp	3
MC 621, 622	Marine Botany	Su	3, 3
MC 631–632	Ichthyology		4, 4
MC 634	Marine Invertebrate Zoology	Su	3
MC 636, 637	Fisheries Biology		3, 3
MC 641, 642	Biochemistry of Marine Organisms		3, 3
MC 643, 644	Environmental Pollution		3, 3
MC 651, 652	Physical Oceanography		3, 3
MC 653, 654	Field Work in Oceanography	Su	3, 3
MC 655, 656	Advanced Physical Oceanography		3, 3
MC 657	Marine Acoustics	F	3
MC 658	Marine Acoustics	Sp	3
MC 659	Meteorology	F	3
MC 661	Marine Geochemistry	F	3
MC 662, 663	Marine Sedimentation		3, 3
MC 674, 675	Marine Sanitary Microbiology		3, 3
MC 681	Marine Instrumentation	F	3
MC 682	Marine Instrumentation	Sp	3
MC 691	Marine Operations	Sp	3
MC 693, 694	Ocean Engineering		3, 3
MC 695, 696	Advanced Ocean Engineering		3, 3
MC 701, 702	Marine Science Seminar		1, 1
MC 707, 708	Research and Thesis		3, 3

The instructional staff for the courses listed above consist of the following:

Freudenthal, Hugo D., Ph.D., Department Chairman
Cahn, Phyllis, Ph.D., Associate Professor, Fish Behavior
Claus, George, Ph.D., Associate Professor, Algae Physiology
Devine, Michael, M.S., Assistant Professor, Oceanography
Freudenthal, Peter, M.S., Adjunct Assistant Professor, Meteorology
Fujiya, Masaru, Ph.D., Research Associate, Fisheries Biology
Hamlin, Norman, M.S., Special Lecturer, Ocean Engineering
Hope, Richard, B.L., Associate Professor, Marine Operation

McIllroy, William Ph.D., Adjunct Associate Professor, Acoustics
Newman, Bernard, Ph.D., Adjunct Associate Professor, Sanitary Microbiology
Price, David, M.S., Assistant Professor, Ocean Engineering
Uzzo, Anthony, M.S., Assistant Professor, Instrumentation
Romer, Harold, M.S., Adjunct Professor, Environmental Engineering
Jones, Jo Ann, Ph.D., Research Associate
Madri, Peter, Research Associate
Siler, William, Research Associate
Greenberg, Chester, Manager of Operations

To obtain further information, address all inquiries directly to:

Dr. Hugo D. Freudenthal, Chairman
Graduate Department of Marine Science
Long Island University, Mitchel Campus
10 Merrick Avenue
East Meadow, New York 11554

LONG ISLAND UNIVERSITY (SOUTHAMPTON CAMPUS)
Southampton, New York

The Division of Natural Sciences instructional, laboratory and research space approximates 20,000 sq. ft. which includes a one acre campus marine station of 3,000 sq. ft. with docking facilities. Vessels owned and operated by the Division include one 28 ft., two 24 ft. and two 17 ft. boats which are equipped for instructional and appropriate research activity. At present larger vessels are chartered.

The **B.A. in Marine Science** is offered by the Natural Science Division. All marine science majors must take the following courses as prerequisites with division:

Mathematics 1, 2, 101, 102 College math through the calculus.
Physics 1–2 Introductory physics.
Biology 1–2 (General) or Geology 1-2 (General)
Chemistry 1-2 (General), Chemistry 113 (Quantitative Analysis).

All marine science majors must take the marine science sequence: MS 1-2, 110-111, 190, 197-198 (Senior Seminar).

All majors must choose one area of concentration from:

(a) Biological: Biology 101, 103, 180 or 172, MS 141, 110 or 111, Chemistry 111-112 (Organic).
(b) Chemical: Chemistry 111-112, 114, 115-116, Electives (6 credits).
(c) Geological: Geology 101, 103-104, 105-106, 112, 113, 136.

All majors then have to take 10-16 hours electives plus approximately 44-50 hours in the humanities, social science and language.

Courses in the basic areas of biology, chemistry and geology are offered by the appropriate subdivisions of the Natural Science Division. The marine science faculty offers the MS labeled courses at the marine station.

Marine Science Department			
Marine Science 1–2	Introduction to Marine Science	F, Sp	2, 2
Marine Science 110	Physical and Chemical Oceanography	Sp	4
Marine Science 111	Biological and Geological Oceanography	F	4
Marine Science 141	Marine Ecology	Su	3
Marine Science 190	Marine Science Summer Program	Su	6
Biology Department			
Biology 101	Systematic Botany	F	3
Biology 103	Invertebrate Zoology	F	3
Biology 110	Microbiology	Sp	3
Biology 111	Genetics	F	4
Biology 172	Plant Physiology	Sp	3
Biology 180	Animal Physiology	F	3
Chemistry Department			
Chemistry 111–112	Organic Chemistry	F, Sp	4, 4
Chemistry 113	Quantitative Analysis	F, Sp	4
Chemistry 114	Instrumental Analysis	Sp	3
Chemistry 115–116	Physical Chemistry for the Life Sciences	F, Sp	4, 4
Geology Department			
Geology 101	Mineralogy	F	3
Geology 103–104	Sedimentation and Stratigraphy	F, Sp	3, 3
Geology 105–106	Optical Mineralogy and Petrology	Alt. F, Sp	3, 3
Geology 112	Meteorology	Alt. F	3

Geology Department–*Continued*

Geology 113	Paleontology	Alt. F	3
Geology 137	Marine Geology	Alt. F	3
Natural Science 193–194	Special Problems in Marine Science	F, Sp	1–3, 1–3

The instructional staff for the courses listed above consists of the following:

Natural Science Division

Burke, W. T., Ph.D., Director of Division and Professor of Biology
Balthaser, L. H., Ph.D., Assistant Professor of Geology; Marine Science
Briles, G. H., Ph.D., Assistant Professor of Chemistry
Coher, E. I., Ph.D., Associate Professor of Biology
Danziger, R., Ph.D., Assistant Professor of Chemistry
Frankenfield, R. K., M.S., Assistant Professor of Marine Science
Haresign, T. W., Ph.D., Associate Professor of Biology
Siegel, A., Ph.D., Associate Professor of Chemistry, Marine Science
Weiss, R. L., Ph.D., Assistant Professor of Geology
Welker, J. R., M.S., Assistant Professor of Marine Science

To obtain further information, address all inquiries directly to:

Admissions Office
Southampton College
Southampton, New York 11968

LOUISIANA STATE UNIVERSITY
Baton Rouge, Louisiana

Louisiana State University is developing a comprehensive program of research, and resource development of the State's coastal marshes, estuaries and gulf waters. Because of the complex environment, the program requires an interdisciplinary approach utilizing interdepartmental capabilities. It is the intent of the University to develop a full-scale capability as a marine institution and to serve this region in all areas of aquaculture and mineral resources. The University has had a cooperative instructional program at the Gulf Coast Research Laboratory, Ocean Springs, Mississippi since 1956. The Department of Zoology and Physiology established its Industrial Research Laboratory, which concentrates on problems of water pollution, in 1958. The University Coastal Studies Institute was organized in 1954 and its staff has had many years' experience in deltaic, marsh, estuarine, and other coastal research on all continents of the world except Antarctica.

Several institutes at the University support programs related to sea research. The Louisiana State Law Institute was established in 1938; more recently, the Institute for Environmental Sciences, Institute for Land Use and Economic Development, Louisiana Water Resources Research Institute, and the Institute for Saline Studies have been established.

The following degrees are offered by the University:

1. No undergraduate degrees are offered in marine sciences. The **Bachelor of Science** may be taken with major emphasis in related fields.
2. **MS** in Food Science and Technology, Wildlife and Fisheries, Geography (with concentration in Coastal Geography), Geology, Marine Science (Coastal Physical Oceanography), Zoology.
3. **Ph.D.** in Food Sciences and Technology, Geography (with concentration in Coastal Geography), Geology, Marine Science (Coastal Physical Oceanography), Zoology.

The following courses are offered in conjunction with the above programs:

Department of Food Science and Technology

143	Food Technology
144	Food Technology
182	Plant Metabolism
190	Food Enzymes
207	Food Composition and Analysis
230	Research in Fisheries Products
271	Seminar in Food Science
272	Seminar in Food Technology
300	Thesis Research
400	Dissertation Research

School of Forestry and Wildlife Management

121	Ichthyology
124	Fur Animal Management
125	Limnology
126	Pond and Stream Management
225	Advanced Game Management–Waterfowl
230	Fishery Pathology
232	Fishery Research Technology
234	Wildlife Population
300	Thesis Research

School of Geology

Department of Geology

124	Deltaic Geology
131	Introduction to Sedimentation
141	Introductory Geophysics
159	Introductory Geochemistry
227	Seminar in Special Phases of Geology

Department of Geology–*Continued*

233–234	Analysis of Sediments
253	Paleoecology

Department of Geography and Anthropology

116	Hydroclimatology
118	Microclimatology
121	Alluvial Morphology
175	Transportation
177	Economic Geography
182	Biogeography
184	Paleogeography
119	Photo Interpretation
120	Photo Interpretation
141	Field Geography
123	Remote Sensing
126	Coastal Environments–Natural
127	Coastal Environments–Cultural
123	Coastal Morphology
124	Deltaic Morphology
170	Ethnology of Pacific Basin
241	Coastal Ecology
242	Coastal Climatology
246	Coastal and Estuarian Resources
245	Coastal Ethnography
221	Research and Field Work
223	Research and Field Work

Department of Marine Science

216	Coastal and Shallow-Water Literature
217	Coastal Swamps and Marshes
221	Elements of Geophysical Fluid Dynamics
222	Gravity Waves in Shallow Water
223	Shore Dynamics
224	Form-Process Relationships in Coastal Environments
225	Estuarine and Shallow-Water Oceanography
226	Coastal Sedimentary Environments
231	Geochemistry of Coastal Waters, Soils and Sediments
232	Methods of Geochemistry
298	Advanced Reading and Literature Research
299	Advanced Field Research
300	Thesis Research
400	Dissertation Research

Department of Microbiology

161	Microbiology of Water, Sewage, and Industrial Wastes
200	Electron Microscopy of Biological Materials
221	Virology

Department of Zoology and Physiology

151	Marine Biology
153	Animal Ecology
154	Invertebrate Zoology
236–237	Seminars in Ecology
238–239	Seminars in Systematics, Evolution, and Zoogeography
297–298	Research
300	Thesis Research
400	Dissertation Research

The instructional staff for the courses listed above consists of the following:

Allen, R. Scott, Ph.D., Head and Professor of Biochemistry
Avault, James W., Jr., Ph.D., Assistant Professor of Wildlife Management
Amborski, Robert L., Ph.D., Assistant Professor of Microbiology
Baker, John B., Ph.D., Professor of Plant Pathology
Bennett, Harry J., Ph.D., Professor of Zoology & Physiology
Billings, Gale K., Ph.D., Assistant Professor of Geology
Brown, Clair A., Ph.D., Professor of Botany & Plant Pathology
Coleman, James M., Ph.D., Assistant Professor of Coastal Studies Institute, and Department of Marine Sciences
Colmer, Arthur R., Ph.D., Alumni Professor of Microbiology
Culley, Dudley D., Jr., M.S., Assistant Professor of Forestry & Wildlife Management
Ferm, John C., Ph.D., Professor of Geology and Coastal Studies
Ferrell, Ray E., Hr., Ph.D., Assistant Professor of Geology
Gagliano, Sherwood M., Ph.D., Assistant Professor of Coastal Studies Institute, and Department of Geography and Anthropology
Glascow, Leslie L., Ph.D., Professor of Forestry and Wildlife Management
Gosselink, James, Ph.D., Associate Professor of Botany and Marine Science
Grodner, Robert M., Ph.D., Associate Professor of Food Science and Technology
Harman, Walter J., Ph.D., Professor and Chairman of Department of Zoology and Physiology
Ho, Clara L., Ph.D., Assistant Professor of Coastal Studies Institute; Department of Marine Science
Knight, H. Gary, LLB, Assistant Professor of Law; Department of Marine Science
Lee, Jordan G., Ph.D., Professor of Biochemistry
Lewis, James, Ph.D., Assistant Professor of Geography and Anthropology
Liuzzo, Joseph A., Ph.D., Associate Professor of Food Science and Technology
Loesch, Harold, Ph.D., Professor of Zoology; Department of Marine Science
Lovell, Richard T., Ph.D., Associate Professor of Food Science and Technology
Lowery, George H., Jr., Ph.D., Boyd Professor of Zoology & Physiology and Director of Museum of Natural Science
Lowy, Bernard, Ph.D., Professor of Botany and Plant Pathology
Martinez, Joseph, Ph.D., Professor of Environmental Engineering; Department of Marine Science
McIntire, William G., Ph.D., Professor of Geography and Anthropology, and Coastal Studies Institute; Department of Marine Science
Meyers, Samuel P., Ph.D., Professor of Food Science; Department of Marine Science
Morgan, James P., Ph.D., Professor of Geology
Moore, Clyde H., Jr., Ph.D., Assistant Professor of Geology
Muller, Robert, Ph.D., Associate Professor of Geography and Anthropology
Murray, Stephen P., Ph.D., Assistant Professor of Coastal Studies Institute; Department of Marine Science
Normand, Wilbert C., Ph.D., Assistant Professor of Botany and Plant Pathology
Novak, Arthur F., Ph.D., Professor and Head of Department of Food Science and Technology
Perkins, Robert F., Ph.D., Associate Professor of Geology
Risinger, Gerald E., Ph.D., Assistant Professor of Biochemistry
Rossman, Douglas A., Ph.D., Associate Professor of Zoology and Physiology
Socolofsky, Marion D., Ph.D., Professor and Chairman of Department of Microbiology
Smith, William G., Ph.D., Assistant Professor of Coastal Studies Institute; Department of Marine Science
Sonu, Choule J., Ph.D., Associate Professor of Coastal Studies Institute; Department of Marine Science
Standifer, Leonidas C., Jr., Ph.D., Associate Professor of Plant Pathology
Van Lopik, Jack R., Ph.D., Professor and Chairman of Department of Marine Science

Walker, H. J., Ph.D., Professor of Geography and Anthropology and Coastal Studies Institute
West, Robert, Ph.D., Professor of Geography and Anthropology and Coastal Studies Institute
Williams, Virginia R., Ph.D., Professor of Biochemistry

To obtain further information, address all inquiries directly to:

Dr. Jack Van Lopik, Chairman
Department of Marine Science
Louisiana State University
Baton Rouge, Louisiana 70803

LOUISIANA STATE UNIVERSITY IN NEW ORLEANS
Lake Front, New Orleans, Louisiana

LSU in New Orleans is located on the shore of Lake Pontchartrain from which access to the Gulf of Mexico is afforded by the Intercoastal Waterways, the Mississippi River and connecting bayous and canals. The College of Sciences has a small vessel suitable for estuarine studies which is well equipped with field equipment supported by adequate laboratory-based facilities.

The facilities of the Marine Laboratory located on Grand Terre Island, Louisiana, may be made available upon request through cooperation with the Louisiana Wild Life and Fisheries Commission. These facilities consist of several research vessels and a land-based seawater laboratory located on the Gulf of Mexico. Similarly, the facilities and vessels of the State of Mississippi's Gulf Coast Research Laboratory, Ocean Springs, Mississippi, may be made available upon request. The facilities of the U. S. Department of the Interior at Pascagoula, Mississippi, include several fishery research vessels, and may be made available for intermittent periods through cooperative research programs. All of these locations are directly on the Gulf of Mexico within 90 miles of New Orleans.

The LSU System holds charter membership in the Gulf Universities Research Corporation, which is described in the Consortia section of this publication.

No degrees are offered in oceanography, but **the bachelors degree is offered in biological sciences, chemistry, earth sciences, engineering sciences and physics; the M.S. degree is offered in biological sciences, chemistry and physics; the Ph.D. degree is offered presently in the Department of Chemistry.**

The University considers that specialization in Marine Science should be undertaken within one of the classical scientific disciplines such as biological sciences, chemistry, earth sciences, engineering sciences, and physics. Although undergraduate degrees are offered in these areas, graduate studies rather than undergraduate studies, are emphasized in the interdisciplinary marine sciences program. There is no separate department offering work toward a degree in oceanography. The Committee on Oceanography will assist students who wish to prepare themselves for work in this special field, and will help them arrange a joint program of study when that is desired in any of the above disciplines.

The following courses are offered in conjunction with the above programs:

Department of Biological Sciences		
116	Aquatic Microbiology	4
117	Limnology and Oceanography	4
150	General Ecology	4
154	Invertebrate Zoology	4
155	Comparative Physiology	4
203	Malacology	3
Department of Earth Sciences		
166	Sedimentation and Sedimentary Petrology	3
181	Introduction to Geophysics	4
182	Earth Physics	3
185	Introduction to Oceanography	3

The instructional staff for the courses listed above consists of the following:

Dundee, D. S., Ph.D., Professor of Biological Sciences
Olmsted, C. A., Ph.D., Associate Professor of Biological Science
Otvos, E. G., Ph.D., Assistant Professor of Earth Sciences
Stern, D. H., Ph.D., Assistant Professor of Biological Sciences
Weidie, A. E., Ph.D., Associate Professor of Earth Sciences
Wolleben, J. A., Ph.D., Assistant Professor of Earth Sciences

To obtain further information, address all inquiries directly to:

Dr. Clinton A. Olmsted
Chairman, Committee on Oceanography
College of Sciences
Louisiana State University in New Orelans
Lake Front, New Orelans, Louisiana 70122

UNIVERSITY OF MAINE
Orono, Maine

The university offers marine science courses at both its main campus in Orono and its new marine research station, the Ira C. Darling Center for Research, Teaching and Service, at Walpole. Pertinent facilities on the main campus include a new zoology building with adequate classroom and laboratory facilities for marine sciences research and the University Computing Center which has an IBM 360, Model 30 computer. At Walpole, 100 miles south of the campus, facilities on a 136-acre site include a classroom, well-equipped research laboratories, all-weather living accommodations for 22 students, library, the 43-foot R/V DRAKE and several skiffs with outboards. A pier to provide deep-water docking facilities is under construction. Southern Maine Vocational Technical Institute's 134-foot AQUALAB is available at South Portland for cooperative use.

The University offers the degree of **Ph.D. in Oceanography**. The degree program is administered by the Oceanography Steering Committee in cooperation with the various science departments. At present, only students wishing specialization in biological oceanography will be admitted to the program. A student must apply for admission to one of the biology departments (Bacteriology, Biochemistry, Botany and Plant Pathology or Zoology) and indicate on the application the wish to pursue studies in Biological Oceanography. Acceptance by both the Biology Department and the Oceanography Steering Committee (OSC) is required for admission to the program.

Departmental requirements must be satisfied in addition to those specified by the OSC. The latter include: (1) Zo 170, a prerequisite to all advanced courses in Oceanography, (2) a minimum of one summer, or the equivalent, at a marine station while engaged in an approved marine activity, (3) research experience at sea, (4) preparation of an acceptable thesis, (5) having a minimum of one member of the OSC serve on the student's graduate committee, and (6) a reading knowledge of two foreign languages.

Students wishing to specialize in a marine problem without entering the oceanography curriculum may seek admission to M.S. or Ph.D. programs in one of the science departments.

The following courses in the marine sciences are offered during the academic year at the main campus by the Departments indicated. Problems-type courses and a summer course are offered at the Darling Center.

Department of Botany and Plant Pathology (Bt)			
163	Introductory Phycology	Sp	4
Department of Zoology (Zo)			
132	Ichthyology	Sp	4
153	Invertebrate Zoology	F	4
168	Limnology	Sp	4
170	Introduction to Oceanography	Sp	3
171	Fish Management	F	4
210	Marine Invertebrate Zoology	Su	5
357	Population Dynamics	F	2
362	Estuarine Ecology	F	4
369	Introduction to Biological Oceanography	F	4
370	Advanced Topics in Aquatic Biology	Sp	(Credit Variable)
392	Problems in Zoology (Functional Anatomy of Marine Invertebrates)	Sp	3
393, 394	Problems in Biological Oceanography	Sp, F	(Credit Variable)
399	Thesis		

The instructional staff for the courses listed above consists of the following:

Department of Botany and Plant Pathology

Vadas, Robert L., Ph.D., Assistant Professor of Botany

Department of Geology

Fink, L. Kenneth, Jr., Ph.D., Assisatant Professor of Geology

Department of Zoology

Dean, David, Ph.D., Professor of Zoology
Dearborn, John H., Ph.D., Assistant Professor of Zoology
Haefner, Paul A., Jr., Ph.D., Associate Professor of Zoology
Hatch, Richard W., Ph.D., Associate Professor of Zoology
McAlice, Bernard J., Ph.D., Assistant Professor of Zoology
McCleave, James D., Ph.D., Assistant Professor of Zoology
Meyer, Marvin C., Ph.D., Professor of Zoology

To obtain further information, address all inquiries directly to:

The Dean of the Graduate School
University of Maine
Orono, Maine 04473

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts

Graduate education in oceanography is carried out as a cooperative effort by the Departments of Earth and Planetary Sciences and of Meteorology, and leads to master's and doctor's degrees in oceanography, geology, geophysics and meteorology. Through a joint degree program in oceanography with Woods Hole Oceanographic Institution the degrees of doctor of philosophy and doctor of science are awarded jointly by both institutions. Normally, students in oceanography at M.I.T. are considered to be in the joint M.I.T.-W.H.O.I. program.

The educational program requires students to become conversant with applied mathematics and other fundamentals, stressing the need for quantitative and deliberate inquiry rather than emphasizing the more routine aspects of oceanography. A student will normally spend his first year or two at M.I.T., and then do his thesis research either at M.I.T. or at Woods Hole, dependent upon location of his advisors and the facilities needed.

Instruction in oceanography is offered by the Departments of Meteorology and of Earth and Planetary Sciences at M.I.T. and by the Woods Hole Oceanographic Institution. Many other M.I.T. departments offer subjects in marine sciences and engineering in addition to subjects basic to oceanography. Thus this section should be read in conjunction with the section of this book on the Woods Hole program and the section on the M.I.T. program in Ocean Engineering.

While M.I.T. maintains a small dock facility in Boston and has a 50 ft. research vessel, used for local observations, instrumentation tests and courses, Woods Hole Oceanographic Institution maintains a fleet of ocean going research vessels with a concomitant shore facilities. In addition, M.I.T. has other extensive facilities–laboratories, classrooms, libraries, computing and data processing services, etc.

In accordance with the program described above, the following degrees are offered:

1. **Ph.D. and Sc.D. in Oceanography** offered by M.I.T. (Department of Earth and Planetary Science and Department of Meteorology)

2. **Ph.D. and Sc.D.** offered jointly by M.I.T. and W.H.O.I. For the doctorate a student is required to pursue a program of advanced study leading to a general examination; to demonstrate ability in research by presentation and defense of a thesis; to meet language requirements (ability to read scientific literature in two acceptable foreign languages, or a more extensive reading and speaking knowledge of one), and certain residence requirements.

3. **Master of Science in Oceanography** offered by M.I.T. alone (Department of Earth and Planetary Sciences, Department of Meteorology). For the master's degree a student must complete an academic program of 66 credit units, of which 42 must be graduate "A" subjects, and a thesis, during at least one year of residence.

The following courses are offered in conjunction with the above programs:

Undergraduate Courses		
12.09	Geology III	12
12.21	Physical Oceanography	12
19.83	Physical Oceanography I	12
Graduate Courses		
12.32	Sedimentology and Sediment Movement (A)	12
12.325	Sedimentology Seminar (A)	6
12.502	Interpretation Methods In Regional Geophysics	9
12.73	Marine Geodesy (A)	9
12.81	Waves and Tides (A)	12
12.815	Seminar in Physical Oceanography	9
12.829	Research in Chemical Oceanography	12
12.891–12.899	Seminar in Oceanography (A)	
12.901–12.909	Special Problems in Oceanography	
12.91	Research in Physical Oceanography (A)	
19.22	Air and Sea Instruments (A)	11

Graduate Courses—*Continued*

19.24	Fluid Dynamics Laboratory (A)	8
19.601	Introduction to Dynamical Meteorology	9
19.62	Dynamic Meteorology I	9
19.64	Dynamic Meteorology II (A)	12
19.65	Turbulence and Random Phenomena in Fluid Mechanics	12
19.67	Planetary Fluid Dynamics (A)	12
19.80	Surface and Internal Waves (A)	9
19.84	Dynamic Oceanography (A)	9
19.86	Ocean Circulations (A)	9
19.87	Seminar in Physical Oceanography (A)	9
19.89	Special Problems in Oceanography (A)	
19.97	Special Subject in Oceanography (A)	

Other Related Courses

Department of Mathematics

18.60	Introduction to Fluid Mechanics
18.611	Rotating Fluids
18.612	Introduction to Geophysical Fluid Dynamics
18.62	Hydrodynamic Stability and Turbulence
18.656	Wave Motion

Other Departments

1.69	Waves and Coastal Processes
1.70	Mechanics of Sediment Transport
2.283	Fluid Mechanics of Pollution
6.573	Introduction to Random Processes

The Institute also offers undergraduate, graduate and professional programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Earth and Planetary Sciences

Press, Frank, Ph.D., Head of Department and Professor of Geophysics
Biehler, Shawn, Ph.D., Asssistant Professor of Geophysics
Simmons, M. Gene, Ph.D., Professor of Geophysics
Southard, John B., Ph.D., Assistant Professor of Geology
von Arx, W. S., Sc.D., Professor of Physical Oceanography, part-time; Regular staff member at Woods Hole Oceanographic Institution
Wunsch, Carl I., Ph.D., Assistant Professor of Oceanography

Department of Meteorology

Houghton, Henry G., S.M., Head of Department and Professor of Meteorology
Beardsley, Robert C., Ph.D., Assistant Professor of Oceanography
Charney, Jule G., Ph.D., Professor of Meteorology
Keily, Delbar P., S.B., Associate Professor of Meteorology
Mollo-Christensen, Erik L., Sc.D., Professor of Meteorology
Phillips, Norman A., Ph.D., Professor of Meteorology
Rhines, Peter B., Ph.D., Assistant Professor of Oceanography
Starr, Victor P., Ph.D., Professor of Meteorology
Stommel, Henry M., B.S., Professor of Oceanography

To obtain further information, address all inquiries directly to:

Professor Frank Press, Head
Head of Earth and Planetary Sciences
Room 54-912
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Professor H. G. Houghton, Head
Department of Meteorology
Room ~~54-1~~712
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

UNIVERSITY OF MASSACHUSETTS
Amherst, Massachusetts

The Marine Science program presently centers around the classroom, laboratory, and library facilities on the Amherst campus of the University of Massachusetts. In addition, certain staff members now have laboratory use privileges, by arrangement, at the Woods Hole Marine Biological Laboratories and at the Bureau of Commercial Fisheries laboratory in Gloucester, and similar arrangements can be made for appropriate student research projects. The University is presently arranging for its own quarters in the Gloucester area, which will include both a coastal research station and housing facilities. The University maintains a property on Nantucket Island which may be used by arrangement.

The University maintains a number of trailer-transported motor boats for work in coastal waters, and anticipates acquisition of a larger coastal boat. University staff and students participate in research and training cruises on deep sea vessels by arrangement with cooperating institutions, including Woods Hole Oceanographic Institution, University of Rhode Island, and Duke University. It is anticipated that offshore marine work requiring large vessels will continue to be done through such arrangements for at least the next several years. University workers may also serve at sea on a variety of fishing vessels as well as on the research vessel of the Bureau of Commercial Fisheries.

The University offers the degree of **Master of Science in Marine Science** (thesis required). Students may specialize in any of the following disciplines: Aerospace Engineering, Agricultural Engineering, Botany, Civil Engineering, Geology, Fisheries, Food Sciences, Mechanical Engineering, Microbiology, Zoology.

COURSE WORK IN THE PROGRAM

Every student will take a core of four 3 credit courses:

a. Physical Oceanography (Geology 655), Mr. Hayes.
b. Geological Oceanography (Geology 752), Mr. Webb.
c. Biological Oceanography (Marine Sciences 501), biological staff.
d. Chemical Oceanography.

In addition, the student takes a minimum of 15 credit hours in the specialty option of his choice (Geology, Botany, Zoology, Fisheries, Food Science and Technology, Marine Microbial Ecology, or Engineering). These may be taken in one or more departments, but with a minimum of 6 of these credits in the student's chosen area. At least 6 credits must be in the 700-900 courses, which may include seminar credits. The individual's particular course of study will be selected in consultation with his advisor, governed by his interests and scientific background.

The student will do a research problem, either as a special problem or as a thesis:

a. Marine Science 700 (Special problem) up to 6 credits.
b. Marine Science 800 (Master's thesis), 6-8 credits.

The choice between the thesis and the special problem will be made with regard to the requirements of the department in which the student elects his specialty option. The work will be done under the direct supervision of a faculty member from the department of the student's choice who is himself actively engaged in marine-oriented work, although he need not be a member of the marine sciences committee. The degree candidate must pass a comprehensive written examination on the subject matter of the core curriculum and a qualifying examination in the chosen specialty option similar in general to the qualifying examination which may be required in that department. In some specialty options, the degree candidate must pass the graduate reading examination or its equivalent in one foreign language (French, German, or Russian).

The program is administered by the graduate school through the Marine Sciences Committee, members of which will advise the student.

The following courses are offered in conjunction with the above program. Those courses appropriate to inclusion in the specialty option are identified by an asterisk.

Botany	
501	Biological Oceanography
521 (221)	Ecology
Engineering	
556*	Introduction to Hydrodynamics
559*	Fluid Mechanics of the Oceans
560*	Hydrology
561*	Open Channel Flow
562*	Hydraulic Engineering
700	Special Problems in Oceanographic Engineering
Fisheries Biology	
700*	Special Problems in Wildlife or Fisheries Biology
701*	Seminar in Wildlife and Fisheries Biology
756*	Fisheries Biometrics
757*	Advanced Fisheries Management
565*	Techniques of Fisheries Biology
570*	Ecology of Fishes
572*	Introduction to Marine Fisheries
Geology	
655*	Physical Oceanography
752*	Geological Oceanography
756*	Coastal Processes
751*	Sedimentation
723*	Sedimentary Petrology
782*	Petroleum Geology
846*	Cenozoic Stratigraphy
786*	Ground Water Geology
666*	Pleistocene Geology
670*	Geophysics
520*	Lithology
540*	Invertebrate Paleontology
550*	Sedimentology and Stratigraphy
Marine Science	
567*	Microbial Ecology of Marine Environment
Zoology	
271*	Invertebrate Zoology
302*	Ichthyology
337*	Population and Community Ecology
370*	Comparative Physiology
583*	General Parasitology
660*	General and Cellular Physiology
740*	Advanced Invertebrate Zoology
744*	Helminthology (Biology of Commensalism)

The instructional staff for the courses listed above consists of the following:

Wilce, Robert T., Ph.D., Associate Professor, Department of Botany; Director, Program of Marine Science
Andrews, Thomas J., M.S., Associate Professor, Zoology
Bemben, Stanley M., Ph.D., Assistant Professor, Civil Engineering
Carver, Charles E., Jr., Ph.D., Professor, Civil Engineering
Chajes, Alexander, Ph.D., Assistant Professor, Civil Engineering
Cole, Charles F., Ph.D., Associate Professor, Fisheries Biology
Colonell, Joseph M., Ph.D., Assistant Professor, Civil Engineering
Cromack, Duane E., M.S., Assistant Professor, Mechanical and Aerospace Department

Drum, Ryan W., Ph.D., Assistant Professor, Botany
Dzialo, Frederick J., Ph.D., Associate Professor, Civil Engineering
Edwards, Dallas C., Ph.D., Assistant Professor, Zoology
Eldridge, John W., Ph.D., Professor and Head, Chemical Engineering
Fillo, John, Ph.D., Assistant Professor, Mechanical and Aerospace Department
Fultz, Sara A., Ph.D., Assistant Professor, Botany
Hayes, Miles O., Ph.D., Assistant Professor, Geology
Heronemus, William E. (USN, ret.), M.S., Professor, Civil Engineering
Hutchinson, Charles E., Ph.D., Associate Professor, Electrical Engineering
Kirk, Robert S., Ph.D., Associate Professor, Chemical Engineering
Lenz, Robert W., Ph.D., Associate Professor, Chemical Engineering
Levin, Robert E., Ph.D., Assistant Professor, Food Science and Technology
Litsky, Warren, Ph.D., Professor, Agricultural and Industrial Microbiology
Livingston, Robert B., Ph.D., Professor, Botany
McGowan, Jon G., Ph.D., Assistant Professor, Mechanical and Aerospace Department
Miller, Melton M., Jr., Ph.D., Assistant Professor, Civil Engineering
Monopoli, Richard V., Ph.D., Associate Professor, Electrical Engineering
Murthy, S. N. B., Ph.D., Visiting Lecturer, Mechanical and Aerospace Department
Nash, William A., Ph.D., Professor, Mechanical and Aerospace Department
Nawar, Wassef W., Ph.D., Associate Professor, Food Science and Technology
Nutting, William B., Ph.D., Professor, Zoology
Ritter, John E., Jr., Ph.D., Assistant Professor, Mechanical and Aerospace Department
Roberts, John L., Ph.D., Associate Professor, Zoology
Roberts, Larry S., Sc.D., Assistant Professor, Zoology
Russell, Albert G., Ph.D., Assistant Professor, Mechanical and Aerospace Department
Stumbo, Charles R., Ph.D., Professor, Food Science and Technology
Webb, Gregory W., Ph.D., Associate Professor, Geology
Wyse, Gordon A., Ph.D., Assistant Professor, Zoology
Zahradnik, John W., Ph.D., Professor, Agricultural Engineering

To obtain further information, address all inquiries directly to:

Dr. Gregory W. Webb, Director
Program of Marine Science
University of Massachusetts
Amherst, Massachusetts 01002

UNIVERSITY OF MIAMI
Coral Gables, Florida

The University's Institute of Marine Sciences originated as the Marine Laboratory in 1943. Research facilities include the Radar Meteorological Laboratory at Main Campus, an underwater acoustic-video system in a reef area off the coast of Bimini, a 45-mile underwater acoustic range from Miami to Bimini, and a station on Barbados for study of wind-transported continental materials. The Institute operates an experimental nursery for pink shrimp and pompano at Turkey Point on Biscayne Bay and a field laboratory at Pigeon Key in the Florida Keys for studies of marine biology, calcium carbonate deposition, and mangrove ecology. The Institute also operates two large research vessels and a number of small craft.

The majority of the academic program of the Institute is at the graduate level, although two undergraduate courses are offered. The Institute's graduate program is taught by scientists actively engaged in research. Students normally elect one of the following major subject areas for their specialty: Marine Biology, Functional Biology, Marine Geology and Geophysics, Physical and Chemical Oceanography, Fisheries Sciences, and Atmospheric Science. Students who show research ability and meet the necessary requirements may take part in investigations being carried on as part of the Institute's research program.

M.S. degrees are offered in **Marine Biology, Functional Biology, Marine Geology-Geophysics, Physical-Chemical Oceanography, and Atmospheric Sciences.** All students are required to complete thirty course credits, a thesis representing original research or critical review of literature on a topic approved by the staff, an examination demonstrating the reading knowledge of a foreign language (French, German, or Russian), and a comprehensive examination covering a general understanding of the major field as well as courses taken.

Ph.D. degrees are offered in **Marine Biology, Functional Biology, Marine Geology-Geophysics, and Physical-Chemical Oceanography**. All students are required to obtain permission from their advisory committee and petition the Academic Faculty of the Institute to enter the Ph.D. program. The student must spend at least two consecutive semesters beyond the first year's graduate work in full-time study at the University of Miami Institute of Marine Sciences.

At least 36 graduate credits in courses and seminar are required (these may include courses taken for the M.S. degree, excluding thesis credits), plus 24 credits for the Dissertation. Up to 12 credits may be transferred from other institutions if approved. A reading knowledge of two languages is required, and the second language should be completed within one year after entering the Ph.D. program.

The following courses are offered in conjunction with the above programs:

Physical and Chemical Oceanography

201	Introduction to Oceanography	F	3
202	Ocean and Laboratory Studies in Oceanography	F	1
501	General Oceanography	F	3
502	Laboratory for Biologists and Geologists	F	1
503	Laboratory for Physical-Chemical Oceanography	F	1
510	Physical Oceanography	Sp	3
511	Geophysical Fluid Dynamics I	F	3
512	Geophysical Fluid Dynamics II	Sp	3
520	Chemical Oceanography	F	4
521	Surface and Colloid Chemistry	F	2
522	Physical Chemistry in the Earth Sciences	Sp	3
532	Radar Meteorology	By announcement	3
542	Time Series Analyses	Sp	3
581, 582	Supervised Projects	F, Sp	2
602	Physical Oceanography Seminar	Sp	1
603	Chemical Oceanography Seminar	Sp	1

Physical and Chemical Oceanography—*Continued*

611	Oceanic Circulation and Dynamic Oceanography	F	3
612	Waves and Tides	F	3
613	Underwater Acoustics	Sp	3
614	Optical Oceanography	By announcement	3
620	Selected Problems of Chemical Oceanography	By announcement	4
631	Air-Sea Interaction	Alt. F	3
671, 679	Advanced Studies in Physical and Chemical Oceanography	F, Sp	2–3

Marine Geology and Geophysics

551	Marine Geology	F	4
553	Sedimentation	Sp	4
554	Sedimentary Petrology	F	4
558	Geochemistry	Sp	4
561	Geophysics	Sp	4
571	Special Studies	F, Sp	1–4
581, 582	Supervised Projects	F, Sp	2
601	Marine Sciences Seminar	Sp	1
605	Seminar in Marine Geology and Geophysics	F	1
621	Isotopic Processes in Earth Sciences	By announcement	3
622	Analytical Methods in Geochemistry	By announcement	4
652	Carbonate Sedimentation	F	3
653	Advanced Sedimentation	Sp	4
654	Stratigraphic Micropaleontology	Alt. Sp	4
655	Paleoecology	Sp	3
661	Tectonics	Alt. F	3
662	Morphology and Structure of Ocean Basins	Alt. F	3
671, 679	Advanced Studies in Marine Geology and Geophysics	F, Sp	2–3

Marine Biological Science

204	Introduction to Marine Biology	F	4
404	Advanced Marine Biology	Sp	4
G512	Phycology	Sp	4
G531	Marine Microbiology	Sp	4
G541	Marine Biochemistry	By announcement	4
602	Biological Oceanography Seminar		1
604	General Biological Oceanography	F	3
605	General Biological Oceanography Laboratories	F	1
621	Taxonomy of Marine Invertebrates	Sp	4
622	Ecology of Marine Animals	F, Sp	4
623	Invertebrate Embryology	Sp	4
625	Behavior of Marine Organisms	F	4
631	Plankton	F	4
632	Phytoplankton	Sp	4
634	Physiology of Marine Organisms	F	4
671, 679	Advanced Study in Marine Biological Science	F, Sp	2–3
681, 682	Marine Biological Research	F, Sp	2
686	Biology of Fishes	Sp	3
687	Systematics of Fishes	F	4

Fisheries Sciences			
G501	Fishery Biology	F	4
G502	Fishery Technology	Sp	2
G521	Saltwater Pollution Technology		3
602	Fishery Seminar	Sp	1
604	Fish Stocks and Their Management	Sp	4
605	Population Enumeration and Dynamics	F	3
606	Ecology of Marine Parasites	Sp	4
671, 679	Advanced Study in Fisheries	F, Sp	2–3
681, 682	Fishery Research	F, Sp	2
Atmospheric Science			
501	Introduction to Atmospheric Science	F	3
511	Geophysical Fluid Dynamics I	F	3
512	Geophysical Fluid Dynamics II	Sp	3
513	Atmospheric and Oceanic Thermodynamics	By announcement	4
518	Theory of Sensors and Systems	Sp	3
521	Physical Meteorology	Sp	3
542	Statistical Methods in Geophysical Science	By announcement	3
571, 574	Selected Topics in Atmospheric Science	By announcement	3

The University also offers undergraduate and graduate programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Atmospheric Science
Estoque, Mariano, Professor
Geisler, Jack, Assistant Professor
Kraus, Eric, Professor
Latham, Donald, Assistant Professor
Rooth Claes H., Professor

Fisheries Science
Caillouet, Charles W., Associate Professor
Higman, James, Research Scientist
Idyll, Clarence P., Professor
Iversen, Edwin S., Associate Professor
Roessler, Martin A., Assistant Professor
Runnels, Jonnie, Research Scientist
Tabb, Durbin C., Associate Professor
Ward, Benjamin Q., Associate Professor
Yang, Won Tack, Assistant Professor

Marine Biological Sciences
Bayer, Frederick M., Professor
Bunt, John S., Professor
Corcoran, Eugene F., Associate Professor
de Sylva, Donald P., Associate Professor
Fell, Jack, Assistant Professor
Greenfield, Leonard J., Associate Professor
Hughes, David A., Assistant Professor
Lane, Charles E., Professor
Moore, Hilary B., Professor
Myrberg, Arthur A., Associate Professor
Owre, Harding B., Associate Professor

Marine Biological Sciences–*Continued*

- Provenzano, Anthony J., Associate Professor
- Reeve, Michael R., Assistant Professor
- Richard, Joseph D., Assistant Professor
- Robins, Richard, Professor
- Smith, Walton F. G., Professor
- Stevenson, Robert A., Assistant Professor
- Thomas, Lowell P., Assistant Professor
- Voss, Gilbert L., Professor
- Wood, Ferguson, Professor

Marine Geology and Geophysics

- Ball, Mahlon M., Assistant Professor
- Bonatti, Enrico, Associate Professor
- Bostrom, Kurt G., Associate Professor
- Emiliani, Cesare, Professor
- Fisher, David E., Associate Professor
- Gartner, Stefan, Assistant Professor
- Harrison, Christopher G., Associate Professor
- Hay, William W., Professor
- Hurley, Robert J., Associate Professor
- Joensuu, Oiva I., Assistant Professor
- Moore, Donald R., Assistant Professor
- Nagle, Frederick, Assistant Professor
- Neumann, Conrad, Assistant Professor
- Niskin, Shale, Research Scientist
- Rona, Elizabeth, Senior Research Scientist

Physical and Chemical Oceanography

- Bader, Henri, Professor
- Bader, Richard G., Professor
- Broida, Saul, Assistant Professor
- Cratin, Paul D., Associate Professor
- Drost-Hansen, Walter, Professor
- Duing, Walter, Associate Professor
- Gerrish, Harold P., Assistant Professor
- Gerchakov, Saul M., Research Scientist
- Gordon, Howard, Assistant Professor
- Hiser, Homer W., Professor
- Millero, Frank J., Assistant Professor
- Őstlund, Hans Gőte, Professor
- Prospero, Joseph M., Assistant Professor
- Rooth, Claes H., Professor
- Senn, Harry V., Associate Professor

To obtain further information, address all inquiries to:

Dr. Robert J. Hurley, Chairman
Division of Graduate Studies in Marine Sciences
Institute of Marine Sciences
10 Rickenbacker Causeway
Miami, Florida 33149

THE UNIVERSITY OF MICHIGAN

Ann Arbor, Michigan

The Department of Meteorology and Oceanography at the University of Michigan includes laboratories for atmospheric turbulence and scintillation research and studies of cloud and precipitation physics, a computer laboratory containing a hybrid analog-digital computer, meteorological instrumentation, and facilities for general, physical and chemical oceanography and submarine geology.

A fleet of three fully-equipped research vessels maintained in the Great Lakes by the Great Lakes Research Division of the University's Institute of Science and Technology are available for staff and student field studies in oceanography. Though the Great Lakes Research Division is a research facility not directly involved in teaching, it has a firm policy of assisting in the educational program through the research of faculty and students.

The University offers the degrees of **Ph.D. and M.S. in Oceanography** through its Department of Meteorology and Oceanography. An applicant for the degree **Doctor of Philosophy in Oceanography** is expected to have ability and scholarship of a high order in the fundamentals of the science. In oceanography the fundamentals include the following: macro- and micrometeorology, aquatic ecology, sedimentation and stratigraphy, statics and kinematics, geophysics and geochemistry. An applicant will elect such courses as will, in the opinion of the Graduate Guidance Committee for Oceanography, supplement his background and provide him with the techniques needed to carry out independent investigations.

The student may be required to demonstrate his capability in the fundamentals to the Graduate Guidance Committee by passing one or more qualifying examinations before being recommended as an **applicant** for the doctorate. Approximately half of the student's course work should be in oceanography, with at least two additional courses, for a minimum of six credit hours in mathematics, physical science, or engineering science.

An **applicant** may become a **candidate** for the doctorate upon completion of the course requirements, the preliminary examinations, and the general requirements of the Graduate School, including examinations in one foreign language.

A dissertation fulfilling the requirements of the Horace H. Rackham School of Graduate Studies will be required of each candidate. The subject for the dissertation may be selected from any of the several areas in oceanography. A satisfactory oral examination of the candidate on the dissertation and related material, conducted by the doctoral committee, completes the requirements for the degree.

Requirements for the degree **Master of Science in Oceanography** include thirty credit hours of graduate studies, approved by one of the graduate advisers, consisting of a minimum of at least fifteen credit hours of course work in oceanography, and a minimum of six credit hours of mathematics or three credit hours of mathematics and three credit hours of physical science or engineering science. Six credit hours of course work in oceanography may, after agreement with the graduate adviser, be replaced by a thesis.

The following courses are offered in conjunction with the above programs:

Undergraduate Courses

304	Introduction to Atmospheric and Oceanic Sciences I
305	Introduction to Atmospheric and Oceanic Sciences II
306	Laboratory in Geophysical Data I
307	Laboratory in Geophysical Data II
350	Ocean Engineering I
351	Geophysical Fluid Dynamics

Graduate Courses

417	Geology of the Great Lakes
442	Ocean Dynamics I
449	Marine Geology
450	Ocean Engineering II
478	Marine Chemistry

Graduate Courses—*Continued*

531	Marine Ecology
542	Oceanic Dynamics II
550	Ocean Engineering III
579	Atmospheric and Marine Radioactivity
605	Current Topics in Meteorology and Oceanography
701	Special Problems in Meteorology and Oceanography

The University also offers undergraduate, graduate and professional programs in ocean engineering which are described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Meteorology and Oceanography

Wiin-Nielsen, A. C., Ph.D., Chairman and Professor of Meteorology and Oceanography
Ayers, J. C., Ph.D., Professor of Oceanography
Cole, A. L., Ph.D., Lecturer
Dingle, A. N., Sc.D., Professor of Meteorology
Epstein, E. S., Ph.D., Professor of Meteorology
Gill, G. C., M.A., Professor of Meteorology
Hough, J. L., Ph.D., Professor of Oceanography
Jacobs, S. J., Ph.D., Associate Professor of Oceanography
Kuhn, Wm. R., Ph.D., Assistant Professor of Meteorology
Portman, D. J., Ph.D., Professor of Meteorology
Washington, W. M., Ph.D., Adjunct Associate Professor of Meteorology and Oceanography
Winchester, J. W., Ph.D., Associate Professor of Meteorology and Oceanography

To obtain further information, address all inquiries directly to:

Dr. A. Wiin-Nielsen
Chairman
Department of Meteorology and Oceanography
4072 East Engineering Building
University of Michigan
Ann Arbor, Michigan 48104

NAVAL POSTGRADUATE SCHOOL
Monterey, California

The Department of Oceanography offers graduate education in oceanography for naval officers. The oceanography curricula are designed to provide officers with an education in oceanography, with particular application to naval operations, and to enable them through advanced study to conduct independent research. At the present time the Department operates a 63-foot hydrographic research vessel and has modest laboratory facilities ashore. Also utilized are facilities in the Departments of Electrical Engineering, Physics, Mechanical Engineering, and Material Sciences and Chemistry.

The degree of **Master of Science in Oceanography** (with 3 options) is offered.

Departmental Requirements: Entrance to a program leading to the degree of Master of Science in Oceanography requires a baccalaureate degree in a field appropriate to the oceanography option chosen. Minimal requirements include mathematics through differential and integral calculus, one year of college physics, and one year of college chemistry.

The degree of Master of Science in Oceanography requires:

a. Completion of thirty-five quarter hours of graduate courses of which fifteen hours must be in the 4000 Oceanography series. The entire sequence of courses for the particular option selected must be approved by the Department of Oceanography.

b. An acceptable thesis on a topic approved by the Department of Oceanography.

Objectives of the Options in Oceanography:

Physical and Geophysical–To provide a broad basic education in oceanography, including courses in biological, geological, and chemical oceanography. The core element is physical oceanography. Emphasis is placed upon the application of oceanography to naval operations, and practical experience with instruments and observations.

Operations–To provide the broad spectrum of fundamental principles and information included in the ocean sciences. To improve the capability of solving problems associated with surface and underwater warfare including those involving weapons, search, rescue, recovery, salvage, oceanographic data collection, and the support of emplacements and facilities.

The Department of Oceanography offers the following courses. Marine Science and Engineering courses are also offered in the departments of: Mechanical Engineering, Physics, Electrical Engineering, and Material Sciences and Chemistry. Because new groups of officers begin their curricula both in the spring and in the fall, the majority of the listed courses are offered twice each academic year.

Oc 0810	Thesis Research	0–0
Oc 2110	Introduction to Oceanography	3–0
Oc 3150	Geophysical Random Processes	4–2
Oc 3221	Descriptive Oceanography	4–0
Oc 3250	Dynamical Oceanography	4–0
Ph 3250	Underwater Optics	3–2
Oc 3260	Sound in the Ocean	3–0
Oc 3320	Geological Oceanography	3–8
Oc 3420	Biological Oceanography	3–3
Oc 3520	Chemical Oceanography	3–2
Oc 3601	Ocean Wave Forecasting	3–0
Oc 3605	Ocean Wave Forecasting Laboratory	0–6
Oc 3611	Ocean Wave and Surf Forecasting	2–0
Oc 3615	Ocean Wave and Surf Forecasting Laboratory	0–6
Oc 3616	Oceanographic Forecasting	3–0
Oc 3621	Oceanographic Forecasting Laboratory	0–4
Oc 3700	Oceanographic Instrumentation and Observations	3–0
Oc 3710	Field Experience in Oceanography	0–4
EE 3731	Instruments and Equipment for Ocean Operations	4–3
Oc 3801	Ocean Operations	3–1

Oc 4211	Waves and Tides	4–0
Oc 4213	Coastal Oceanography	4–1
Oc 4251	Dynamical Oceanography I	4–0
Oc 4252	Dynamical Oceanography II	4–0
Oc 4253	Dynamical Oceanography III	3–0
Oc 4260	Sound in the Ocean	3–0
Oc 4340	Marine Geophysics	3–0
Oc 4421	Marine Ecology	1–4
Oc 4422	Marine Fouling	1–1
Oc 4612	Polar Oceanography	3–0
Oc 4802	Ocean Operations II	3–1
Oc 4851	Geophysics: Earth Gravity	3–2
Oc 4852	Geophysics: Earth Magnetism and Electricity	3–2
Oc 4853	Geophysics: Sound and Seismicity	4–0
Oc 4860	Physics of the Earth	3–0
Oc 4900	Seminar in Oceanography	3–0
Oc 4901	Seminar in Ocean Operations	1–0

The instructional staff for the courses listed above consists of the following:

Leipper, Dale Frederick, Ph.D., Chairman and Professor of Oceanography
Andrews, Robert Sanborn, M.S., Assistant Professor of Oceanography
Boston, Noel Edward James, M.S., Assistant Professor of Oceanography
Ceres, Robert Lawrence, LCDR, U. S. Navy, M.S., Instructor in Oceanography
Crew, Henry, M.S., Assistant Professor of Oceanography
Denner, Warren Wilson, M.S., Assistant Professor of Oceanography
Geary, Jack Ellsworth, CDR, U. S. Navy, M.S., Assistant Professor of Oceanography
Giles, Claude F., CDR, U. S. Navy, B.S., Instructor in Oceanography
Green, III, Theodore, Ph.D., Assistant Professor of Oceanography
Haderlie, Eugene Clinton, Ph.D., Professor of Oceanography
Jung, Glenn Harold, Ph.D., Professor of Oceanography
Smith, Raymond James, Ph.D., Professor of Oceanography
Thompson, Warren Charles, Ph.D., Professor of Oceanography
Thornton, Edward Bennett, M.E., Assistant Professor of Oceanography
Tucker, Stevens Parrington, M.S., Assistant Professor of Oceanography
von Schwind, Joseph John, Ph.D., Associate Professor of Oceanography
Wickham, Jacob Bertram, M.S., Associate Professor of Oceanography

To obtain further information, address all inquiries directly to:

Dr. Dale F. Leipper, Chairman
Department of Oceanography
Naval Postgraduate School, Code 58
Monterey, California 93940

UNIVERSITY OF NEW HAMPSHIRE
Durham, New Hampshire

Marine science activities at the University are conducted, and degrees granted, within the framework of the fundamental scientific disciplines involving the Science Departments of Biochemistry, Botany, Geology, Microbiology, Physics and Zoology.

The New Hampshire Estuarine Laboratory, constructed in 1969, is located at the junction of Little and Great Bays, approximately five miles from the University at Durham and fifteen miles from the ocean. The Laboratory occupies about 8,400 square feet and contains modern facilities for the Departments of Botany, Biochemistry, Microbiology and Zoology, including a large circulating seawater system and a shop.

The University has skiffs and motored boats suitable for collecting in the estuary. Open ocean work is carried out through arrangements with Woods Hole Oceanographic Institution, Woods Hole, Massachusetts and the Narragansett Marine Station, University of Rhode Island, Kingston, Rhode Island.

The Geology Department's teaching and research facilities are located in a newly renovated building at the University's Durham campus. The proximity of Durham to the Great Bay Estuary, the open-ocean coastal areas of New Hampshire and contiguous states and to the off-shore Isles of Shoals provides easy access to a variety of situations in which marine geological study and research can be conducted.

The Physics Department operates the Underwater Shock-Wave Laboratory, a small scale facility consisting of a 14' x 5' x 4' tank, instrumented with transducers and recording equipment. This facility is being used currently for the study of shock-wave propagation and reflection phenomena from various interfaces as well as shock-wave dissipation in various media.

A Cornell University–University of New Hampshire Summer Program in Marine Science uses facilities at the Isles of Shoals, the Estuarine Laboratory and the University of New Hampshire campus.

The following degrees are offered by the Departments indicated:

1. **Master of Science** (Departments of Biochemistry, Botany, Geology, Microbiology, Physics and Zoology). For the degree of Master of Science in these departments at least 30 credits must be earned, including a minimum of eight credits in courses, not including thesis.

2. **Doctor of Philosophy** (Departments of Biochemistry, Botany, Microbiology, Physics and Zoology). The degree of Doctor of Philosophy in these departments is conferred on qualified candidates who have passed an oral or written examination on the subject matter of their field of study, who have completed an original investigation in this field and have embodied the results in an acceptable dissertation, and who have passed an oral examination in defense of the dissertation.

The following courses are offered in conjunction with the above degrees:

Department of Biochemistry		
895, 896	Graduate Projects	1–3
Department of Botany		
759	Introduction to Biological Oceanography and Marine Ecology	3
780	Marine Phycology	4
880	Advanced Marine Phycology	3–4
Department of Geology		
501	Introduction to Oceanography	4
741	Geochemistry	4
754	Sedimentation-Stratigraphy	4

Department of Geology—*Continued*

759	Geological Oceanography	4
795	Geological Problems	2–4
816	Mineralogy of Clays	3
841	Analytical Geochemistry	3
856	Estuarine and Marine Sedimentation	3
895, 896	Topics in Geology	1–4

Department of Microbiology

708	Marine Microbiology	4
899	Master's Thesis	6–10
999	Doctoral Research	

Department of Physics

899	Master's Thesis	6
999	Doctoral Research	

Department of Zoology

701	Principles of Ecology	3
704	Comparative Endocrinology	3
711	Natural History of Cold-Blooded Vertebrates	4
715	Natural History of Marine Invertebrates	4
803	Marine Ecology	4
820, 821	Invertebrate Zoology	4
822	Protozoology	4
823	The Host-Parasite Relationship	3
826	Comparative Physiology	4
830	Invertebrate Embryology	4

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Biochemistry

Herbst, Edward J., Ph.D., Professor and Chairman of Biochemistry
Green, D. MacDonald, Ph.D., Professor of Biochemistry
Ikawa, Miyoshi, Ph.D., Professor of Biochemistry
Klippenstein, Gerald L., Ph.D., Assistant Professor of Biochemistry

Department of Botany

Mathieson, Arthur C., Ph.D., Assistant Professor of Botany

Department of Geology

Tischler, Herbert, Ph.D., Professor and Chairman of Geology
Anderson, Franz E., Ph.D., Assistant Professor of Geology
Gaudette, Henri E., Ph.D., Assistant Professor of Geology

Department of Microbiology

Slanetz, Lawrence W., Ph.D., Professor and Chairman of Microbiology
Chesbro, William R., Ph.D., Professor of Microbiology
Jones, Galen E., Ph.D., Professor of Microbiology and Director of the Jackson Estuarine Laboratory
Metcalf, Theodore G., Ph.D., Professor of Microbiology

Department of Physics

Hall, Harry H., Ph.D., Professor of Physics
Clark, David C., Ph.D., Associate Professor of Physics

Department of Zoology

Wright, Paul A., Ph.D., Professor and Chairman of Zoology
Borror, Arthur C., Ph.D., Associate Professor of Zoology
Bullock, Wilbur L., Ph.D., Professor of Zoology
Croker, Robert A., Ph.D., Assistant Professor of Zoology

Department of Zoology–*Continued*

Milne, Lorus J., Ph.D., Professor of Zoology
Sasner, John J., Ph.D., Assistant Professor of Zoology
Sawyer, Philip J., Ph.D., Associate Professor of Zoology
Swan, Emery F., Ph.D., Professor of Zoology
Tillinghast, Edward, Ph.D., Assistant Professor of Zoology

To obtain further information, address all inquiries directly to:

Office of Marine Science and Technology
Kingsbury Hall
University of New Hampshire
Durham, New Hampshire 03824

CITY UNIVERSITY OF NEW YORK
New York, New York

The University consists of nine senior and eight junior colleges. Classwork and research space are offered at some of the individual campuses. Through joint appointments, mainly in biological oceanography, additional research space is available at the Lamont-Dougherty Geological Observatory. Students and staff will have access to our 100-foot vessel specially equipped for estuarine and nearshore studies. More extensive oceanic work is possible through CONRAD and VEMA (Lamont-Dougherty Geological Observatory) and EASTWARD (National Science Foundation and Duke University). Special arrangements can also be implemented at a variety of local and sub-tropical research institutions. Facilities of the City University also include mobile field laboratory, working skiff, small launch, combined library holdings of nearly 2 million books and 8,000 periodicals, and assorted computers (an IBM 7040, four IBM 1620's, and an IBM 360-50). (All marine facilities are available to other institutions in the New York, New Jersey and Connecticut area.)

The University offers the following degrees in marine science fields through the departments indicated:*

1. **B.S. in Oceanography, Interdisciplinary Group in Oceanography.** This degree is available only at the City College. Students are required to complete 128 credits with an average of "C" or better. In meeting this standard, students: (a) must take a minimum of 44 credits outside their major subject and a minimum of 36 credits in their major, (b) are unlimited in what they take to meet a maximum of 48 credits as free electives, (c) may take up to 16 credits of non-major study on a pass-fail basis, and (d) must select an approved program of study in an oceanographic discipline.

2. **M.A. in Biology, Chemistry, Geology, Physics, Departments of Biology, Chemistry, Geology, Physics.** Generally speaking, the student must: (a) complete 30 credits in an approved program of study with an average grade of "B" or better, (b) demonstrate a reading knowledge of one foreign language and (c) present an original monograph or additional laboratory research credits. Students in Biology and Chemistry must pass a comprehensive examination.

3. **Ph.D. in Biology, Chemistry, Physics, University Committees in Biology, Chemistry, Physics.** Of the generally 60 credits required for the degree, only students studying chemical oceanography would be required to take a specific array of courses (Advanced Inorganic Chemistry, Advanced Organic Chemistry, Quantum Chemistry, Chemical Thermodynamics and Basic Laboratory Techniques for Research). All students are required to complete an approved program of study and to pass a First Examination (comprehensive) and a Second Examination (special field). A dissertation is required in all programs. Only Biology and Chemistry require the student to demonstrate a reading knowledge of two foreign languages. These same two University Committees require that their students display competence in college teaching.

Undergraduate courses are offered to qualified residents of New York State on a nominal or free basis. Graduate programs are open to qualified applicants whether residents of New York State or not. Marine geology is centered at Queens College; marine biology at the City College. Students are not limited to taking courses at their own campus. Some graduate and undergraduate marine courses are offered in the summer, but realistically a student should presume courses leading to a degree only during the regular year. Oceanographic training at all levels is accomplished through special course work added to the usual science and engineering departments.

The following courses are offered by the University by the departments indicated in conjunction with the University's degree programs:

Biology

111	Biology of Vertebrates	F, Sp	4
112	Biology of Invertebrates	F, Sp	4
216	Principles of Ecology	F, Sp	2
221	Lower Plants	F	4
274	Biological Oceanography	Sp	4

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*A Ph.D. in Geology is proposed for the 1969-70 academic year.

Biology—*Continued*			
293	Senior Seminar	F, Sp	2
298	Independent Study. Honors.	F, Sp	Usually 4
301–304			
762, .1	Physiological Ecology	*	3
761.1, .2	Marine Plankton Dynamics	*	3
761.3, .4	Marine Benthos	*	3
761.7, .8	Marine Microbiology	*	3
761.9	Marine Ecology	*	4
790.63	Seminar In Biological Oceanography	Sp	3
791	Colloquium	F, Sp	1
792	Tutorial	F, Sp	4
899	Independent Doctoral Research	F, Sp	Max 10
Chemistry			
12	Inorganic Chemistry	F, Sp	4
30–33	Physical Chemistry, I and II	F, Sp	10 Total
46	Chemical Instrumentation	F, Sp	4
55–56	Organic Chemistry, I and II	F, Sp	10 Total
59	Biochemistry	F, Sp	4
99.301–304	Independent Study. Honors	F, Sp	4–16
710	Advanced Inorganic Chemistry	*	3
750, 751	Advanced Organic Chemistry I and II	F	3
760	Introductory Quantum Chemistry	Sp	3
810.1-.4	Doctoral Research	F, Sp	(Variable)
Geology			
27, 28	Structural Geology I and II	†	4 each
21	Invertebrate Paleontology	Sp	4
25	Sedimentation and Sedimentary Petrography	F	2
30, 31	Stratigraphy I, II	†	4 each
32	Petrology	F, Sp	4
37	Geochemistry of Minerals	F	4
38	Petrographic Minerology	Sp	4
61	Introduction to Geophysics	F	4
64	Physical Oceanography	F, Sp	4
65	Marine Geology	F	4
70	Field Geology		4
Physics			
9, 10	Mechanics	F, Sp	4 each
13	Thermodynamics	F, Sp	4
55	Physical Meteorology	Sp	4
56	Dynamic Meteorology	F	4

The instructional staff for the courses listed above consists of the following. Unless otherwise indicated, all staff are based at the City College.

University Committee in Oceanography

Posner, Gerald S., Ph.D., Executive Officer for Oceanography and Associate Professor of Biology

Donn, William L., Ph.D., Professor of Geology

Lee, John J., Ph.D., Associate Professor of Biology

McIntyre, Andrew, Ph.D., Assistant Professor of Geology, Queens College

Thurber, David, Ph.D., Associate Professor of Geology, Queens College

Tietjen, John H., Ph.D., Assistant Professor of Biology

*Offered in Alternate Years.
†Offered in Alternate Semesters.

Biology

Brody, Marcia, Ph.D., Associate Professor of Biology, Hunter College
Goldstein, Solomon, Ph.D., Associate Professor of Biology, Brooklyn College
Hecht, Max, Ph.D., Professor of Biology, Queens College
Koulish, Sasha, Ph.D., Assistant Professor of Biology, Richmond College
Lee, John J., Ph.D., Associate Professor of Biology
Pierce, Stanley, Ph.D., Assistant Professor of Biology, Queens College
Posner, Gerald S., Ph.D., Associate Professor of Biology
Rachlin, Joseph, Ph.D., Instructor of Biology, Lehman College
Roels, Oswald, Ph.D., Adjunct Professor of Biology
Sacks, Martin, Ph.D., Associate Professor of Biology
Shields, Robert W., Ph.D., Assistant Professor of Biology
Tavolga, William N., Ph.D., Professor of Biology
Tietjen, John H., Ph.D., Assistant Professor of Biology

Chemistry

Barrett, Edward, Ph.D., Assistant Professor of Chemistry, Hunter College
Blei, Ira C., Ph.D., Assistant Professor of Chemistry, Richmond College
Haines, Thomas H., Ph.D., Associate Professor of Chemistry
Soloway, Saul, Ph.D., Associate Professor of Chemistry
Wiley, Richard H., Ph.D., Professor of Chemistry, Hunter College

Geology

Burckle, Lloyd, M.S., Lecturer in Geology, Hunter College
Coch, Nicholas, Ph.D., Assistant Professor of Geology, Queens College
Donahue, Jack, Ph.D., Assistant Professor of Geology, Queens College
Donn, William L., Ph.D., Professor of Geology
Fagan, John, Ph.D., Assistant Professor of Geology
Feeley, Herbert, Ph.D., Associate Professor of Geology, Queens College
Habib, Daniel, Ph.D., Assistant Professor of Geology, Queens College
Krinsley, David, Ph.D., Professor of Geology, Queens College
Loring, Arthur, Ph.D., Assistant Professor of Geology, York College
McIntyre, Andrew, Ph.D., Assistant Professor of Geology, Queens College
Mencher, Ely, Ph.D., Professor of Geology
Newman, Walter S., Ph.D., Assistant Professor of Geology, Queens College
Schaffel, Simon, M.S., Lecturer in Geology
Thurber, David, Ph.D., Associate Professor of Geology, Queens College

Meteorology

Ehrlich, Albert, Ph.D., Associate Professor of Geology
Rommer, Richard, M.S., Lecturer in Geology
Stolov, Harold, Ph.D., Associate Professor of

Physics

Brown, M. Vertner, Ph.D., Professor of Physics
Guthrie, Albert, Ph.D., Professor of Physics, Brooklyn College
Thorndike, Edward, Ph.D., Professor of Physics, Queens College

To obtain further information, address all inquiries directly to:

Dr. Gerald S. Posner
Executive Officer for Oceanography
The City College
Convent Avenue and 138th Street
New York, New York 10031

THE MARITIME COLLEGE OF THE STATE UNIVERSITY OF NEW YORK
New York, New York

The college offers marine science courses at its main campus at Fort Schuyler as well as aboard the training ship, the EMPIRE STATE IV. The five-story Science Wing (Marvin Hall) in the new Science and Engineering Building accommodates the various laboratories of the College's Science Department. The Digital Computer Laboratory on the first floor is equipped with an IBM-1130 Digital Computer (including a card-reader-punch and a printer), key punches, card sorter and various types of desk calculators.

The two-story Nuclear Reactor Laboratory, and the Advanced Physics Laboratory, on the first floor, are designed for experiments in Atomic, Nuclear and Reactor Physics. The facilities of the Nuclear Reactor Laboratory include a Nuclear Reactor Simulator that reproduces the control and operation functions of a nuclear power reactor, a sub-critical water-moderated reactor assembly loaded with 6,000 lbs. of natural uranium which permits experimental studies of neutrons and their properties, a neutron pulse generator, a neutron howitzer, a gamma ray spectrometer, a multichannel analyzer with linear display, and a variety of nuclear radiation detection and counting equipment.

The Meteorology Laboratory, Weather Station and lecture area occupy the entire top floor. The roof is designed as an observation deck and provides instrumentation and facilities for the instruction of an entire class in recording weather data. A 40-foot steel tower supports weather instruments which read out to indicators in the classroom and laboratory. Teletype and facsimile machines provide weather data from all of North America and ships at sea. Students plot and analyze weather maps and prepare forecasts.

The R. J. Reynolds Planetarium in the fort houses the model A-1 Spitz projector. A series of three-dimensional models is used to explain the intrinsic structure of the universe as well as its apparent configuration to a terrestrial observer.

An Astronomical Observatory on the roof of the fort was completed in July 1965. The 16 foot 6 inch true hemispherical dome is electrically controlled, while the transverse shutters, offering a 48-inch clear opening, are operated through a torque converter. Both visual and photographic work can be pursued at the observatory.

The EMPIRE STATE IV, the former USNS HENRY GIBBINS of the Military Sea Transportation Service, was built in Ingall's Shipyards, Pascagoula, Mississippi, in 1943. She served as a troop transport during World War II and on MSTS routes until assigned to the Maritime College in December, 1959. The modified C-3 has accommodations for 340 cabin passengers and 740 troops. The 12,000-ton ship is 489 feet in length, with a beam of 69 feet. Her geared steam turbine develops 8500 horsepower and a cruising speed of 16 knots.

During the academic year, the training ship is berthed at Fort Schuyler. Facilities are available on board for laboratory sessions in marlinspike seamanship, marine engineering, communications and electronic aids to navigation. During the summer months, the ship is steamed on the annual training sessions across the Atlantic.

The Oceanography Laboratory aboard the EMPIRE STATE IV offers students the opportunity during the Summer Atlantic cruises to utilize deep sea oceanographic gear. Instruction is provided in the use of: Nansen bottles, reversing thermometers, bathythermographs, infrared thermometers, inductive salinometers, current meters, and turbidity meters, as well as radiosonde and pilot balloon instrumentation.

The 600-foot College Pier provides convenient and adequate docking space for the EMPIRE STATE IV. A boat shed adjacent to the pier is used to house and to launch and retrieve the small boats. A tidal gauge station is situated close to the pier. The basin inshore of the pier is used for mooring the racing sloops and recreational sailing craft of the college.

The course of studies in the Meteorology and Oceanography curriculum includes the practical and theoretical nautical training prerequisite for licensed deck officers together with a complete series of courses designed to provide a thorough understanding of the fundamental principles underlying the sciences of meteorology and oceanography. Combined with the professional work, cadets will pursue courses in the humanities and social sciences that are of importance in the liberal education of youth.

Theory and practice are integrated by relating the scholastic efforts of the academic year to those of the Summer Sea Training Period on the college training ship during the summer months.

The cadets who successfully complete the courses required by this curriculum receive the degree of **Bachelor of Science (Meteorology and Oceanography)** and, after passing the required U. S. Coast Guard examinations, a Federal license as Third Mate in the Merchant Marine, and if acceptable can obtain a commission as Ensign in the U. S. Naval Reserve.

The curriculum for cadets majoring in Marine Nuclear Science includes an extensive preparation in mathematics, physics, chemistry and metallurgy as well as in the humanities and social studies. The complete set of courses is designed to establish a firm foundation for a professional career in the immediate and foreseeable future. The individual courses have been designed to prepare cadets for the professional duties involved in operation, research and development of nuclear energy, as well as to prepare them in the necessary practical nautical training required to become licensed ship officers.

Cadets who successfully complete the course of studies in this major receive the registered and accredited degree of **Bachelor of Science (Marine Nuclear)** and are eligible to take the Third Engineer's U. S. Coast Guard operating engineer's license examination; and, if acceptable to the U. S. Navy, they can obtain an Ensign's commission in the U. S. Naval Reserve.

The following courses are offered in conjunction with the above programs:

Meteorology

202	General Meteorology	3
305	Synoptic Meteorology I	3
306E	Synoptic Meteorology II	3
310	Dynamic Meteorology I	3
311	Meteorology for Mariners	3
411	Dynamic Meteorology II	3
422E	Weather Forecasting	3
423E	Thesis	
432E	Applied Meteorolgoy	3
442E	Research	
452	Instruments	3
454	Meteorological Observations	1

Oceanography

303	General Oceanography I	3
304E	General Oceanography II	3
305	Oceanographic Instruments	3
406	Applied Oceanography	3
410E	Oceanography	3
413	Dynamic Oceanography I	3
414E	Dynamic Oceanography II	3

The College also offers undergraduate programs in ocean engineering and the training of seagoing officers which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Science

Meir H. Degani, Sc.D., Chairman and Professor of Physics
Alvin E. Kinney, Ed.D., Executive Officer and Professor of Mathematics
Meyer Bouscher, M.S., Instructor of Mathematics
Vito Cifichiello, M.S., Associate Professor of Physics
David Epstein, Ph.D., Associate Professor of Oceanography
Fred C. Hess, Ed.D., Professor of Chemistry
Salomon E. Liverhant, M.S., Professor of Physics
Joseph D. Longobardi, M.S., Associate Professor of Physics
George McGinn, Ph.D., Assistant Professor of Physics
Peter M. Perry, A.B., Technical Specialist

Department of Science—*Continued*

Joseph J. Pescatore, Ph.D., Assistant Professor of Chemistry
Ellis J. Rich, M.S., Instructor of Mathematics
Jay R. Schwartz, M.A., Assistant Professor of Mathematics
Vincent L. Teofilo, MNE, Instructor of Physics
Charles Thor, M.S., Associate Professor of Meteorology
Stephen G. Tolchin, M.S., Instructor of Physics
Hersh Zemel, M.S., Assistant Professor of Meteorology

To obtain further information, address all inquiries directly to:

Dr. M. H. Degani
Chairman, Science Department
State University of New York Maritime College
Fort Schuyler
New York, New York 10465

NEW YORK UNIVERSITY
Bronx, New York

Current research projects include studies of ocean waves, air-sea boundary processes, solar radiation balance, turbulent dye diffusion, large scale ocean circulation, and the equatorial Atlantic. Extensive analogue and digital computing facilities such as an IBM 360/30, BECKMAN 210, and smaller units are available. A sixty-five foot research ship, the KYMA, equipped with AC and DC power, radar, loran, gyrocompass, fathometer, Doppler navigator, deep sea winch, BT winch, dye diffusion gear, skin diving equipment, and data telemetry electronics is used for oceanographic investigations.

The following degrees are offered in Marine Science:

1. **Ph.D. (Department of Meteorology and Oceanography).** At least 60 of the 72 required credits must be in meteorology, oceanography, physics, mathematics, or chemistry, and, of these 60 credits, at least 42 must be in meteorology and oceanography. Students whose major interest is meteorology are expected to acquire a basic knowledge of physical and dynamical oceanography. Students whose major interest is oceanography are expected to acquire a basic knowledge of meteorology. The program of each student is subject to approval by his adviser.

A reading knowledge of any one of the following languages is required: German, French, Japanese, Russian; in certain cases another foreign language may be subsituted on petition by the student.

Qualifying examinations in physics and mathematics are to be taken as early as possible in order to qualify students to take courses beyond the Master's level.

A student who has spent at least one year in residence, who has either passed a foreign language proficiency test or is registered in a course in an appropriate foreign language, and has passed qualifying examinations in mathematics and physics, may apply to the Department Chairman for admission to **provisional candidacy** for the Ph.D. degree. The student is then assigned to a faculty committee with whom he meets regularly for guidance and demonstration of his potentiality as a doctoral candidate. The committee determines, after about one academic year, whether the student is to be accepted as a candidate for the Ph.D. degree.

The doctoral dissertation is a scholarly presentation of the candidate's original research on a problem of importance in meteorology or oceanography; 6 credits are granted upon acceptance of the dissertation in either T69.3305-3306 or T69.3309-3310. The final general examination will comprise topics in the field of the candidate's dissertation.

2. **M.S. in Oceanography or Meteorology (Department of Meteorology and Oceanography).** For the Degree of Master of Science: a minimum of 36 credits of which 24 must be in the Department is required. Also required is a paper, suitable for publication, according to either of two alternative plans, the choice of which is made by the student with the permission of his adviser:

Plan A. An acceptable research thesis demonstrating the student's ability to attack and solve a scientific or technical problem, for which a maximum of 6 credits will be granted by registration in T69.2307 for two terms.

Plan B. An essay consisting of a critical review of the literature in a selected area of meteorology or oceanography, for which a maximum of 3 credits will be granted by registration in either T69.2304 or T69.2308.

3. **B.S. in Meteorology and Oceanography (Department of Meteorology and Oceanography).** The curriculum leading to a B.S. degree includes intensive study in mathematics and physics, and the basic courses in physical, descriptive, and dynamic meteorology and oceanography.

The following courses are offered in conjunction with the above programs:

T69.0030–40	Introduction to the Geophysical Sciences	F, Sp	8
T69.0050–60	Dynamic Meteorology and Oceanography	F, Sp	6
T69.0051–61	Descriptive Meteorology and Oceanography	F, Sp	6
T69.0071	Theoretical Geophysics	F	3
T69.0077	Oceanography I	F	3
T69.0087	Oceanography II	Sp	3

T69.0080	Statistical Methods in the Geophysical Sciences	F	3
T69.1102	Principles of Meteorological and Oceanographic Instruments	F	3
T69.1103–1104	The Planet Earth	F, Sp	6
T69.1107	Statistical Methods in Meteorology and Oceanography	Sp	3
T69.1151–1152	Physical Oceanography	F, Sp	6
T69.1701	Air Pollution Chemistry	F	3
T69.1702	Air Pollution Analysis	Sp	3
T69.2201–2202	Weather Analysis	F, Sp	6
T69.2203–2204	Dynamic Meteorology	F, Sp	
T69.2206	Atmospheric Radiation	Sp	3
T69.2207–2208	Atmospheric and Oceanic Turbulence	F, Sp	6
T69.2211–2212	Weather Prediction	F, Sp	6
T69.2217–2218	Special Topics in Meteorology	F, Sp	6
T69.2219–2220	Physics of the Upper Atmosphere	F, Sp	6
T69.2221	The Atmospheres of the Planets	F	3
T69.2224	Radiometeorology	Sp	3
T69.2225–2226	Geophysical Hydrodynamics	F, Sp	6
T69.2230	Meteorological Measurements by Rockets and Satellites	Sp	3
T69.2235–2236	Atmospheric Chemistry and Radioactivity	F, Sp	6
T69.2237–2238	Atmospheric Physics	F, Sp	6
T69.2239	General Circulation of the Atmosphere	F	3
T69.2251	Special Topics in Oceanography	F	3
T69.2256	Analysis and Forecasting of Ocean Waves	Sp	3
T69.2258	Selected Problems in Oceanography	Sp	3
T69.2261–2262	Oceanographic Field Research	F, Sp, Su	6
T69.2263–2264	Analysis of Oceanographic Data	F, Sp, Su	6
T69.2267	Oceanography for Engineers I	F	3
T69.2268	Oceanography for Engineers II	Sp	3
T69.2269	Oceanography and Space Technology	F	3
T69.2270	Electromagnetic Properties of Sea Water	Sp	3
T69.2272	Transmission of Sound in Sea Water	Sp	3
T69.2303	Research Methods in Meteorology and Oceanography	F	3
T69.2304	Research in Meteorology	F &/or Sp	3
T69.2307	Research for the Master's Thesis	F &/or Sp	3
T69.2308	Research in Oceanography	F &/or Sp	3
T69.2727	Microclimate and Dispersion of Pollutants	Sp	3
T69.2749	Air Pollution Engineering Control	Sp	3
T69.2766	Air Pollution Effects	Sp	3
T69.3305–3306	Advanced Research in Meteorology	F &/or Sp	6
T69.3309–3310	Advanced Research in Oceanography		6

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Meteorology and Oceanography

Miller, James E., M.S., Chairman and Professor of Meteorology
Neumann, Gerhard, Dr. Rer. Nat., Professor of Oceanography
Pierson, Willard J., Jr., Ph.D., Professor of Oceanography

Department of Meteorology and Oceanography–*Continued*

Schotland, Richard M., Sc.D., Professor of Meteorology
Spar, Jerome, Ph.D., Professor of Meteorology
Friend, James P., Ph.D., Associate Professor of Atmospheric Chemistry
Ooyama, Katsuyuki, Ph.D., Associate Professor of Meteorology
Kirwan, Albert D., Jr., Ph.D., Associate Professor of Oceanography
Deland, Raymond J., Ph.D., Research Associate Professor of Meteorology
Posmentier, Eric S., Ph.D., Assistant Professor of Oceanography
Cardone, Vincent J., M.S., Lecturer in Meteorology

To obtain further information, address all inquiries directly to:

Chairman, Department of Meteorology and Oceanography
School of Engineering and Science
New York University
University Heights
Bronx, New York 10453

NORTH CAROLINA STATE UNIVERSITY
Raleigh, North Carolina

Marine science courses and related studies are offered on the Raleigh campus and at the following off-campus facilities:

1. The Pamlico Marine Laboratory is a newly established facility near Aurora, North Carolina. The primary research interests encompass the effects of man's activities on the estuarine and marine environment. Current research programs include a study of estuarine circulation using Rhodamine B dye, phosphorus cycling in an estuary in relation to a phosphate mining development, macro- and micro-distribution of zooplankton, benthic invertebrate production and distribution, phytoplankton studies including primary productivity and the determination of algal nutrient requirements, a study of bacterial heterotrophy in estuaries, and the physiological effects of fluorides on invertebrates and aquatic plants. The physical facilities include three laboratory buildings, a dormitory and various research vessels, the largest of which is a 35-foot shrimp trawler. One building is furnished with two salt water flow-through systems for the maintenance and culture of estuarine organisms. Two large walk-in coolers are also available for temperature and photoperiod control. Six one-half acre ponds have recently been constructed for experimental work. These ponds are designed to simulate natural estuaries but are subject to environmental control. A large series of smaller pools with flow-through control is also available.

2. The Hatteras Marine Laboratory is located at the southern end of Hatteras Island, North Carolina. Both northern and southern faunas are found in adjacent waters. There is a main office laboratory building and a large dissecting room and facilities for maintaining live organisms. Research programs include population dynamics of marine fishes.

3. The Radiobiological Laboratory at Beaufort, North Carolina, conducts studies of productivity, cycling of elements through the marine environment, and effects of radionuclides on morphology and physiology of marine organisms. Modern research laboratories with special facilities for irradiating and maintaining organisms are provided.

The University offers both the **Ph.D. and M.S. in Marine Science** through cooperating Departments. The requirements for the major for the Ph.D. degree are determined by the student's advisory committee. Normally, these will include four of five core courses (General, Physical, Biological, and Chemical Oceanology, and Marine Geology). Other courses will be selected from the general listing of courses in areas related to Marine Science. A doctoral candidate will be expected to take the Marine Science seminar at least twice during his period of study. A period of residence at a marine station or on an oceanographic cruise in a program approved by the supervisory committee is required. Requirements for the minor, the language, comprehensive examinations, admission to candidacy, the thesis, residence registration for dissertation and final examinations are as provided in the regulations of the Graduate School as described in the Graduate Catalogue.

The M.S. program is essentially similar to the doctoral program except that only three of the five core courses and one semester of seminar are required. Normally, a period of residence at the marine station or on an oceanographic cruise in a program approved by the student's advisory committee will be required. A thesis in a Marine Science-related area is required. Requirements for the minor, the language, admission to candidacy, residence, and final examinations are as provided in the regulations printed in the Graduate Catalogue.

The following courses in Marine Science are offered primarily in four Departments: Botany, Civil Engineering, Geosciences, and Zoology. Those courses in the primary area of marine science are designated as Oceanography courses and are organized in a non-departmental program. Opportunities for summer research are available at the coastal facilities.

CORE COURSES IN MARINE SCIENCE

OC 487	Physical Oceanography	Sp	3
OC 529	Biological Oceanography	Su	3
OC 584	Marine Geology	Sp	3
OC 591	Oceanology Seminar	Sp	1

ADDITIONAL COURSES:

Biological Oceanology

ZO 420	Fishery Science I	F	3
ZO 621	Fishery Science II	F	3
ZO 441	Ichthyology	Sp	3
BO-ZO 442	General Ecology	F	4
GY 486	Weather and Climate	F	2
ZO 515	Growth and Reproduction of Fishes	Sp	3
ZO 517	Population Ecology	Sp	3
ZO 519	Limnology	F	4
ZO 619	Advanced Limnology	Sp	3
BO 574	Phycology	Sp	3
MB 401	General Microbiology	Sp	4
ZO 450	Invertebrate Zoology	Sp	4

Geological Oceanology

GY 452	Exogenic Materials and Processes	F	4
GY 552	Exploratory Geophsyics	Sp	3
GY 563	Applied Sedimentology	Sp	3
GY 567	Geochemistry	F	3
SSC 553	Soil Mineralogy	F	3

Physical Oceanology

OC 581	Introduction to Oceanographic Engineering	F	3
OC 471	Undersea Vehicle Design	Sp	3
CE 517	Water Transportation	F	3
CE 548, 549	Engineering Properties of Soils	F, Sp	3, 3
CE 641, 642	Advanced Soil Mechanics	F, Sp	3, 3
EM 504	Mechanics of Ideal Fluids	F	3
EM 505	Mechanics of Viscous Fluids I	Sp	3
EM 612	Mechanics of Viscous Fluids II	F	3
MAE 651	Principles of Fluid Motion	F	3
MAE 431	Thermodynamics of Fluid Flow	F, Sp	3

These course offerings are supplemented by courses in Marine Science offered by the University of North Carolina at Chapel Hill. Students normally enrolled in this joint program will take courses on each campus.

The instructional staff for the courses listed above consists of the following:

Department of Biochemistry

Longmuir, Ian S., M.B.B., Professor of Biochemistry

Department of Botany

Cooper, Arthur W., Ph.D., Professor of Botany

Department of Civil Engineering

Amein, Michael, Ph.D., Associate Professor of Civil Engineering
Langfelder, L. Jay, Ph.D., Associate Professor of Civil Engineering

Department of Economics

King, Richard A., Ph.D., Professor of Economics

Department of Food Science

Webb, Neil B., Ph.D., Associate Professor of Food Science

Department of Geosciences

Leith, Carlton J., Ph.D., Professor and Head of Geosciences
Lyman, John, Ph.D., Professor of Geosciences
Smith, James R., M.S., Adjunct Assistant Professor of Oceanology
Welby, Charles W., Ph.D., Associate Professor of Geosciences

Department of Mechanical and Aerospace Engineering
Williams, James C., III, Ph.D., Professor of Mechanical and Aerospace Engineering

Department of Soil Science
Woodhouse, William W., Ph.D., Professor of Soil Science

Department of Zoology
Hassler, William W., Ph.D., Professor of Zoology
Hayne, Don W., Ph.D., Professor of Zoology and Experimental Statistics
Hobbie, John E., Ph.D., Associate Professor of Zoology
Horton, Donald B., Ph.D., Assistant Professor of Zoology

Adjunct members, located at U. S. Department of Interior Radiobiological Laboratory, Beaufort, North Carolina:
Angelovic, Joseph W., Ph.D., Adjunct Assistant Professor of Zoology
Rice, Theodore R., Ph.D., Adjunct Professor of Zoology
Williams, Richard B., Ph.D., Adjunct Assistant Professor of Zoology
Wolfe, Douglas A., Ph.D., Adjunct Assistant Professor of Zoology

To obtain further information, address all inquiries directly to:

Dean, Graduate School
Peele Hall
North Carolina State University
Raleigh, North Carolina 27607

THE UNIVERSITY OF NORTH CAROLINA
Chapel Hill, North Carolina

The University of North Carolina at Chapel Hill (UNC-CH) and North Carolina State University at Raleigh (NCSU-R) cooperate to offer a Curriculum in Marine Sciences that involves several departments at each university. This description includes only the facilities and faculty at UNC-CH; see also the description of the NCSU-R program in this publication for full understanding of our joint program.

The University of North Carolina has teaching and research facilities on the Campus at Chapel Hill and at the Institute of Marine Sciences at Morehead City, N. C. Courses are taught on campus in several departments and research projects are also conducted in departmental laboratories. Special research facilities on campus include biological incubators; electron microscopes; gas chromatographs; infra-red spectrometers; atomic absorption spectrometer; liquid scintillation counters; gamma spectrometer; and mass spectrometer. The principle research facility, however, is the Institute of Marine Sciences. A new laboratory building providing 20,000 square feet of space was completed on the shore of Bogue Sound in 1968. The R/V MACHAPUNGA, a 48-foot diesel-powered vessel specially built for estuarine research, is equipped with radio-telephone, fathometer, generators for 100 v. a-c. and 32 v. d-c., and a hydraulic winch for handling gear; it has a 600 mile cruising range and living accommodations for four persons. Several outboard-powered small boats are available. Additional facilities at this coastal laboratory include a library, research collections of fishes, decapod crustaceans, and mollusks, photographic darkroom, radio-isotope facilities, a large pier, a running-saltwater system in a separate wing of the laboratory, large outdoor seawater tanks, and experimental seawater ponds. Research equipment includes microscopes, *in situ* salinometers, sampling bottles, nets, and trawls, pyrheliometers, submarine photometer, oxygen analyzers, histological equipment, gas chromatograph, spectophotometers, and many other types of general laboratory equipment such as hoods, incubators, balances, centrifuges, and pH meters.

The University offers the degrees of **Ph.D. and M.S. in Marine Sciences** under the Curriculum in Marine Sciences. For the Ph.D. degree each student will ordinarily take at least four of the following courses, General Oceanography (101), Physical Oceanography (at NCSU-R, Duke U., or elsewhere), Geological Oceanography (103), Biological Oceanography (104a), and Chemical Oceanography (105), although his committee may approve other courses as satisfactory substitutes. He must also take Seminar in Marine Sciences (206) at least twice and will study or do research at a marine laboratory or on an oceanographic cruise in a program approved by his committee. The dissertation will be on a marine topic. A minor is optional. A reading knowledge of two foreign languages is required; in some cases a research skill such as mathematics, statistics, or information science may be substituted for one language.

For the M.S. degree each student must earn at least twenty-four (24) semester hours of credit, including at least three of the courses listed above for the Ph.D. degree, or substitute courses that are satisfactory to his committee. He must take Seminar in Marine Sciences (206) at least once, and a period of residence at a marine station or on an oceanographic cruise will ordinarily be required. A thesis on a marine topic is required. A minor is optional. A reading knowledge of one foreign language is required.

Courses in the marine sciences are offered during the academic year on the Chapel Hill campus by the Department of Botany, Department of Environmental Sciences and Engineering, Department of Geology, and Department of Zoology. Summer courses are sponsored by the Departments of Botany, Geology, and Zoology are taught at the Institute of Marine Sciences by faculty of these departments and the Institute.

Curriculum in Marine Sciences

101	General Oceanography (Zoology 126)	F	3
103	Geological Oceanography (Geology 173)	Sp	3
104a	Biological Oceanography (Zoology 140a)	Su	6
105	Chemical Oceanography (Environmental Sciences 128)	Sp	3

Curriculum in Marine Sciences—*Continued*			
206	Seminar in Oceanography	Sp	1
300	Research in Marine Sciences	F, Sp, Su	2 or more
393	Master's Thesis	F, Sp, Su	2 or more
394	Doctoral Dissertation	F, Sp, Su	2 or more
Botany Department			
215	Marine Mycology	Su	6
216	Marine Algae	F	5
Department of Environmental Sciences and Engineering			
231	Environmental Microbiology	Sp	3
232	Limnology and Water Pollution	Sp	3
233	Microbial Ecology	F	4
235	Ecology of Phytoplankton (Botany 245)	F	4
Department of Geology			
117	Clay Mineralogy	Sp	4
161	Applied Geophysics	F	4
162	Applied Geophysics	Sp	4
165	Physics of the Earth	Sp	3
247	Sedimentation	F	4
248	Sedimentary Petrology	Sp	4
Department of Zoology			
109	Introduction to Hydrobiology	Sp	4
146	Marine Ecology	Sp	4
156, 157	Advance Marine Invertebrate Zoology	F, Sp	4, 4
208A	Population Ecology	Sp	3
208B	Methods in Population Analysis	Sp	2
213	Advanced Marine Ecology	Sp	3

The instructional staff for the courses listed above consists of the following:

Department of Botany

Hommersand, Max H., Ph.D., Associate Professor of Botany

Department of Environmental Sciences and Engineering

Johnson, J. Donald, Ph.D., Associate Professor of Environmental Chemistry
Kuenzler, Edward J., Ph.D., Associate Professor of Environmental Biology
Lyman, John, Ph.D., Professor of Oceanography
Mah, Robert A., Ph.D., Associate Professor of Environmental Microbiology
Weiss, Charles M., Ph.D., Professor of Environmental Biology

Department of Geology

Ingram, Roy L., Ph.D., Professor of Geology
St. Jean, Joseph, Jr., Ph.D., Professor of Geology
Textoris, Daniel A., Ph.D., Associate Professor of Geology
Watkins, Joel S., Ph.D., Associate Professor of Geology

Department of Zoology

Jenner, Charles E., Ph.D., Professor of Zoology
Odum, Howard T., Ph.D., Professor of Zoology and Botany and Environmental Biology
Riedl, Rupert, Dr. phil. habil., Kenan Professor of Zoology, Research Professor at the Institute of Marine Sciences

Institute of Marine Sciences

Chestnut, Alphonse F., Ph.D., Professor, and Director of the Institute of Marine Sciences
Kohlmeyer, Jan J., Dr. rer. Nat., Assistant Professor in the Institute of Marine Sciences
Schwartz, Frank J., Ph.D., Associate Professor in the Institute of Marine Sciences
Williams, Austin B., Ph.D., Professor in the Institute of Marine Sciences
Woods, William J., Ph.D., Assistant Professor in the Institute of Marine Sciences

To obtain further information, address all inquiries directly to:

Dr. Edward J. Kuenzler
Curriculum in Marine Sciences
University of North Carolina
P. O. Box 630
Chapel Hill, North Carolina 27514

UNIVERSITY OF NORTH DAKOTA
Grand Forks, North Dakota

On the main campus in Grand Forks are four laboratories for fishery biology and limnology teaching and research, a marine aquarium facility, and oceanography teaching laboratory. Related facilities on the campus include the Computer Center containing an IBM 360 system and libraries containing the major fisheries biology, limnology and oceanography journals. The Chester Fritz Library is a Depository Library for Federal Government publications. The University Biological Station at Devils Lake has facilities for limnological and fishery research and boats and equipment for small lake studies.

The University offers the following degrees through the Department of Biology:

1. **Ph.D. in Biology.** The requirements for the Ph.D. degree are 90 post-baccalaureate credits, the majority of which should be in research and dissertation; credits to include 6 in Seminar and 2 or more each in advanced courses in 4 of the following 5 fields: ecology, genetics, morphology, physiology, and systematics; attendance at a marine field station; completion of a comprehensive examination; reading knowledge of two foreign languages or more intensive preparation in one foreign language; preparation and defense of a dissertation.

2. **M.S. in Biology.** The requirements for the M.S. degree are 30 post-baccalaureate credits distributed as 20 in the major and 10 in the minor; the major to include 2 credits in Seminar, 8 credits in research and thesis, and the remaining 10 in advanced courses in at least two of the following five fields: ecology, genetics, morphology, physiology, and systematics. A reading knowledge of one foreign language may be required at the option of the student's advisory committee; preparation and defense of a thesis.

The following courses are offered by the departments indicated in conjunction with the above programs:

Department of Biology			
375	Invertebrate Zoology	Sp	4
425	Ichthyology	F	3
433	Limnology	F	4
438	Fisheries Biology	Sp	4
517	Aquatic Plants	Sp	Alternate Years 3
519	Aquatic Invertebrates	Sp	Alternate Years 3
Department of Geology			
316	Introduction to Oceanography	Sp	3

The instructional staff for the courses listed above consists of the following:

Department of Biology

Duerr, Frederick G., Ph.D., Associate Professor of Biology; Invertebrate Zoology and Physiology

Neel, Joe K., Ph.D., Professor of Biology, Director, Biological Station; Limnology

Owen, John B., Ph.D., Assistant Professor of Biology; Fisheries Biology

Department of Geology

Moore, Walter, Ph.D., Professor of Geology; Geophysics

To obtain further information, address all inquiries directly to:

Dr. Paul B. Kannowski, Chairman
Department of Biology
University of North Dakota
Grand Forks, North Dakota 58201

NORTHEASTERN ILLINOIS STATE COLLEGE
Chicago, Illinois

The oceanography program is an interdepartmental offering. Coastal aspects of oceanography are taught during summer "sea camps" field programs operated in Ensenada (Baja California, Mexico) through special arrangements with the Escuela Superior de Ciencias Marinas of the Universidad Autonoma de Baja California. A vessel of the Mexican Coast Guard provides shipboard experience. Similar arrangements with emphasis on geological and biological aspects of ocean study have been made with the Station de Biologie Marine of the Universite de Bordeaux at Arcachon (France). The Station has two small vessels at its disposal. Students are furthermore encouraged to attend summer sessions at oceanographic stations.

The College does not offer a program leading to undergraduate or advanced degrees in the marine sciences. The undergraduate student, interested in oceanography, may follow a program leading to a B.A. degree in the earth sciences or geography, with concentration in oceanography. The graduate student may obtain an M.A. in geography or earth sciences with concentration in oceanography.

1. **B.A. in Geography**. Nine semester hours in each of the following areas: physical geography, human geography and six hours in regional geography and six hours of geography electives. The electives and six of the nine hours of physical geography may be taken in marine sciences courses.

2. **B.A. in Geography–Secondary Education.** Six hours in each physical, topical, regional geography and twelve hours of electives. The electives and three hours of physical geography may be taken in marine sciences courses.

3. **B.A. in Geography–Elementary Education.** Three hours in each of physical, economic, cultural and Anglo-American geography, plus twelve hours of geography electives. The electives may be taken in marine sciences courses.

4. **B.A. in Earth Science–Elementary Education.** Three hours in each of the following: Earth Science, Meteorology, Economic Geology and Astronomy; twelve hours of electives of which three may be in oceanography.

5. **M.A. in Geography**. The requirements include 27 credits in geography and six for thesis. Three courses (3 credits each) are required: Cartography, Statistics for Earth Sciences and Geography; and Scope and Philosophy of the Geographical Sciences. The remaining 18 credits may be taken in marine sciences courses, and the program must be organized systematically under the guidance of the faculty adviser. The thesis should be written in an area of concentration. A final examination is administered by the faculty of the Geography Department.

6. **M.A. in the Teaching of Geography**. Course requirements are 18 credits in geography–nine in education and six for thesis. The thesis requirements are the same as those for the M.A. in Geography. The only required geography course is Scope and Philosophy of the Geographical Sciences (3 credits). The three education courses totaling nine credits are Principles of Curriculum Development; Television and Related Instructional Media; and Research in the Classroom Teaching of Geography. The remaining 15 credits may all be taken in marine sciences courses.

Students may substitute for a thesis two major research papers to be written under the guidance of two geography faculty members. However, in such cases, six additional credits must be taken in geography courses (marine sciences courses qualify also), and the degree will be considered as terminal rather than leading to further studies.

The following courses are offered in conjunction with the above programs:

43-318	Conservation of Natural Resources	3
43-322	Paleogeography	3
43-343	Polar Geography	3
43-351	Statistics for Earth Sciences and Geography	3
43-352	Guided Study in Geography-Oceanography	1 to 3
43-373	Biological Geography	3
43-374	Cartography	3
43-391	Quantitative Measurements	3
43-421	Climatology	3

43-431	Thesis Seminar	3
43-441	Mathematical Geography	3
53-272	Fundamentals of Meteorology and Climatology	3
53-313	Stratigraphy and Sedimentology	5
53-318	World Regional Geology	3
53-321 43-321	Oceanography	3
53-324	History of the Geological Sciences	1
53-325	Seminars in Earth Science	3
53-326	Individual Study in Earth Science	3
56-317	Ecology	3

The instructional staff for the courses listed above consists of the following:

Department of Geography

Charlier, Roger H., Ph.D., Sc.D., Vice-Chairman and Professor of Geology, Geography and Oceanography
Dierickx, C. Wallace, Ph.D., Chairman and Professor of Geography
Odell, Clarence B., Ph.D., Visiting Professor of Cartography
Schwartz, Carroll, Ph.D., Associate Professor of Geography
Kiang, Ying-Cheng, Ph.D., Associate Professor of Geography
Bernhagen, David, M.A., Instructor in Geography
Easton, Robert, M.A., Instructor in Geography
Mulmat, Kenneth, M.A., Instructor in Geography

Department of Physical Sciences

Forslev, Albert, Ph.D., Professor of Earth Sciences

Department of Biology

Betz, Robert F., Ph.D., Professor of Biology
Wiercinski, Floyd J., Ph.D., Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Roger H. Charlier, Director
Oceanography Programs; Room C630
Northeastern Illinois State College
5500 North St. Louis Avenue
Chicago, Illinois 60625

NORTHEASTERN UNIVERSITY
Boston, Massachusetts

Northeastern University is developing a marine research institute on a 20-acre site on the shoreline at Nahant, Massachusetts. The marine facility is being utilized by faculty and graduate students for research in areas of biological oceanography, earth science and ocean engineering.

No degrees are offered in oceanography at present, but education undergraduates can major in earth science and all students may receive oceanographic background on cooperative jobs at marine-oriented corporations and firms. Advanced degrees incorporating marine research thesis problems are developed in biology, chemistry, and engineering.

The following courses in Marine Science are offered:

UNDERGRADUATE COURSES

Department of Natural Science

16.131	Oceanography I
16.132	Oceanography II

NOTE: In both courses, field trips are taken to the Woods Hole Oceanographic Institution, Boston Fish Pier, and available research vessels.

GRADUATE COURSES

Biology Department

18.830	Marine Algae
18.905	Marine Microbiology

University College Courses (Degree-oriented, part-time adult education programs)

16.531	Oceanography I
16.532	Oceanography II
16.533	Marine Geology
16.534	Fisheries Oceanography I–Survey of Commercially Important Marine Organisms
16.535	Fisheries Oceanography II–Commercial Fishing Methods, Techniques and Equipment
16.536	Fisheries Oceanography III–Commercial Fishery Products and Their Exploitation

The instructional staff for the courses listed above consists of the following:

Northeastern University Marine Institute

Riser, Nathan W., Ph.D., Director

Department of Earth Sciences

Overcash, J. Rosson, A.M.T., Chairman
Gordon, Bernard L., M.Sc., Assistant Professor

To obtain further information, address all inquiries directly to:

Professor Bernard L. Gordon
Department of Earth Science
Northeastern University
Boston, Massachusetts 02115

NOVA UNIVERSITY
OCEANOGRAPHIC LABORATORY
Fort Lauderdale, Florida

The Oceanographic Laboratory is part of the Physical Science Center of the University. It is housed in a waterfront facility in the Port Everglades area. Classroom and laboratory facilities are available for programs in physical, chemical and biological oceanography. The laboratory operates two small research vessels.

The University offers the **Ph.D. degree in Physical Oceanography, Chemical Oceanography, Marine Biology or Physics with a dissertation in Oceanography.**

Numbered courses with a specified number of credits are not given. The program for each student is adjusted to his needs and background. Pregraduate and survey courses are not given. Instruction is offered in all phases of physical and chemical oceanography and related parts of marine biology. Students are expected, upon completion of their studies, to be conversant with the latest developments in these fields. Dissertation research normally involves work at sea.

The instructional staff for the courses listed above consists of the following:

Richardson, William S., Professor of Oceanography
Carritt, Dayton E., Professor of Oceanography
Yentsch, Charles S., Associate Professor of Marine Biology
Herndon, Roy C., Associate Professor of Physics
Niiler, Pearn P., Assistant Professor of Theoretical Oceanography
Snyder, Russell L., Assistant Professor of Oceanography
Moore, Dennis W., Professor of Theoretical Oceanography
Baig, Stephen, Post Doctoral Fellow in Marine Biochemistry
Moed, Jan, Post Doctoral Fellow in Marine Biochemistry

To obtain further information, address all inquiries directly to:

Dr. William S. Richardson
Oceanographic Laboratory
1901 S.E. 15th Street
Fort Lauderdale, Florida 33316

OLD DOMINION COLLEGE
(To Become OLD DOMINION UNIVERSITY, September 1, 1969)
Norfolk, Virginia

The Institute of Oceanography offers marine science courses at both the main campus of the College in Norfolk and its Oceanographic Research Field Station at Little Creek, Virginia Beach, ten miles from the main campus. Laboratory facilities are available at both locations. Instruction given is wholly on the graduate level. A new oceanography building is scheduled for completion in 1970.

The field laboratory has deep-water docking facilities at Little Creek. These facilities serve as the base for operation of the College's research vessels, the ocean going 64-foot ALBATROSS and the 45-foot ACADIAN REBEL for estuarine and riverine survey work. Although the Institute of Oceanography is primarily involved in graduate education and scientific investigations, summer workshops are held for High School Teachers of Science and Mathematics, and research participation for undergraduate science majors is possible.

The College offers the degree of **Master of Science in Oceanography**. A minimum of twenty-eight semester hours (exclusive of research and thesis) of graduate study will be required for the Master of Science degree with a concentration in Oceanography; from three to six hours of credit will be given for the required research and thesis. Except under special circumstances, only German, Russian, French, or Spanish will be permitted to satisfy the language requirement enunciated by the Graduate Council.

The final examination for the master's degree will be an oral or written examination on the student's thesis and closely related topics given by the student's thesis committee. A student must pass this examination before he may receive his degree. Each graduate student is expected to have ten days of shipboard experience annually.

The following courses are offered in conjunction with the Master's program. Two-semester courses in the marine sciences are offered by the Institute of Oceanography during the academic year at the main campus. Undergraduate level marine science courses are presently offered by the Departments of Chemistry and Biology under the auspices of the Institute of Oceanography.

GRADUATE COURSES:

501*	Oceanographic Instrumentation and Techniques	3
502–503*	Advanced General Oceanography	3
504	Advanced Physical Oceanography	3
505	Dynamic Oceanography	3
506	Ocean Boundary Layer Interactions	3
507–508	Special Topics in Oceanography	3
509	Advanced Meteorology	3
510	Theoretical Chemical Oceanography	3
512	Advanced Chemical Oceanography	3
522	Stratigraphy of Coastal Plains	3
523	Minerals and Mineral Assemblages of Sediments	3
531	Marine Geophysics	3
532	Geochemistry of the Ocean	3
541	Marine Phycology	3
542	Marine Mycology and Microbiology	3
543	Physiology of Marine Plants	3
544	Physiology of Selected Marine Animals	3
554*	Statistics	3
591–592*	Seminar	1
598*	Research	3–6
599*	Thesis	3–6

*Indicates required courses for all candidates for the M.S. degree.

UNDERGRADUATE COURSES

415	General Chemical Oceanography	3
418	Marine and Estuarine Plankton	3

The instructional staff for the courses listed above consists of the following:

Full Time

Johnson, Ronald E., Ph.D., Assistant Professor of Oceanography
Ludwick, John C., Ph.D., Professor of Oceanography
Swift, Donald J. P., Ph.D., Associate Professor of Oceanography
Zaneveld, Jacques S., Ph.D., Professor of Oceanography

Part Time

Gosink, Thomas A., Ph.D., Assistant Professor of Chemistry
Marshall, Harold G., Ph.D., Professor of Biology

To obtain further information, address all inquiries directly to:

Dr. Jacques S. Zaneveld, Director
Old Dominion College
Institute of Oceanography
Norfolk, Virginia 23508

OREGON STATE UNIVERSITY
Corvallis, Oregon

The Department of Oceanography is housed in a four-story Oceanography Building on the Corvallis campus. This building contains 30,000 square feet of office and laboratory space. The laboratories are well equipped for research in each of the aspects of oceanography stressed in our current program.

The newly constructed Marine Science Center is located at Newport on the shores of Yaquina Bay, 56 miles west of Corvallis. One of the three wings of the laboratory building houses research in coastal aspects of oceanography and marine biology. The Center also provides shore support and docking facilities for the Department's research vessels and a new marina for small boats.

Two research vessels, the YAQUINA and CAYUSE, comprise the Oregon State University marine science fleet. The 180-foot YAQUINA is capable of carrying out extended cruises anywhere in the oceans of the world. The vessel carries a crew of 17-21, and can accommodate 19 scientists. She houses eight research laboratories and is outfitted with three oceanographic winches and related gear for effective sampling of all kinds. With a cruising range of 6,500 miles, she can remain at sea for more than 30 days.

The 80-foot CAYUSE is equipped for all types of marine research, and is designed for research in the area of the continental shelf and slope off the Pacific Northwest coast. There are quarters for seven crew members and seven scientists, plus a wet laboratory for hydrographic work, a dry laboratory, and an electronic laboratory. Graduate students in oceanography receive much of their training on the CAYUSE.

The University offers the following graduate degrees in the marine sciences:

1. **Master of Arts in Oceanography**
2. **Master of Science in Oceanography**
3. **Master of Science in Oceanography (Geophysics)**
4. **Master of Science in General Science (no thesis required)**
5. **Doctor of Philosophy in Oceanography**
6. **Doctor of Philosophy in Oceanography (Geophysics)**

Students may specialize in any of the following fields: physical, chemical, biological, radioecological, geological, or geophysical oceanography; geophysics.

The University offers numerous courses in the Marine Sciences. Some courses are offered by the Department of Oceanography in the summer primarily for science teachers. These courses carry graduate credit and can be applied to a minor in oceanography.

The Marine Science Center in Newport offers courses which are biological in nature with emphasis on field study. In some cases credit received for these courses can be applied to an oceanography major.

UNDERGRADUATE COURSES:

Oc 133	Elements of Oceanography	F, W, Sp	3
Oc 331	Introduction to Oceanography	F, W, Sp	3

UPPER DIVISION COURSES CARRYING GRADUATE CREDIT (Courses designated (G) can be applied to a graduate major; courses designated (g) can be applied to a graduate minor only):

Mb 415	Marine Microbiology (g)	Sp	2
Mb 416	Marine Microbiology Laboratory (g)	Sp	2
GS 431	Physical Limnology (G)	W	3
GS 501	Field Research in Physical Limnology	Sp	1–3
Oc 431	Physical Oceanography (G)	F	4
Oc 432	General Physical Oceanography (G)	F	3
Oc 433	Currents and Water Masses (G)	W	3
Oc 434	Estuarine and Shoreline Processes (G)	Sp	3
Oc 438	Light and Sound in the Sea (G)	F	3
Oc 441	Biological Oceanography (G)	F	4

UPPER DIVISION COURSES CARRYING GRADUATE CREDIT—*Continued*

Oc 442	Marine Zooplankton (G)	W	5
Oc 451	Chemical Oceanography (G)	W	4
GS 461	Marine Radioecology (G)	W	3
Oc 461	Geological Oceanography (G)	Sp	4
Oc 480	Marine Geophysics (G)	F	3

GRADUATE COURSES:

Oc 501	Research	Term and hours to be arranged	
Oc 501	Research in Gamma Ray Spectrometry	Term and hours to be arranged	
Oc 503	Thesis	Term and hours to be arranged	
Oc 505	Reading and Conference	Term and hours to be arranged	
Oc 507	Seminar	Term and hours to be arranged	
Oc 507	Seminars:		
	Readings in Biological Oceanography	F, W, Sp	1, 1, 1
	Readings in Chemical Oceanography	F, W, Sp	1, 1, 1
	Readings in Geophysics	F, W, Sp	1, 1, 1
	Physics of the Earth	W	3
	Gamma Ray Spectrometry	W	No Credit
	Marine Radioecology	F, W, Sp	1, 1, 1
G 540	Micropaleontology	F	4
Oc 542	Marine Nekton	Sp	3
Oc 543	Marine Nekton Laboratory	Sp	1
Oc 544	Marine Phytoplankton Ecology	F	3
Oc 545	Marine Phytoplankton Physiology	W	3
Oc 546	Marine Primary Production	Sp	5
Oc 547	Marine Phytoplankton Systematics	W	3
Oc 548	Marine Benthic Ecology	F	4
Oc 552	Chemical Oceanography	W	4
Oc 553	Descriptive Chemical Oceanography	F	4
Oc 554	Theoretical Chemical Oceanography	F	4
Oc 565	Geology of the Ocean Basins	W	3
Oc 566	Marine Sedimentation	Sp	3
Oc 568	Ecology of Foraminifera	W	3
Oc 569	Distribution of Modern Foraminifera	W	2
Oc 570	Theoretical Physical Oceanography	W	4
Oc 571	Marine Hydrodynamics	F	4
Oc 573	Waves and Tides	Sp	4
Oc 575	Oceanographic Analysis*	F	1–3
Oc 576	Turbulence I* (alternate years)	W	3
	Turbulence II* (alternate years)	W	3
	Stratified Fluids*	W	3
Oc 577	Boundary Oceanography*	Sp	2
Oc 580	Theoretical Geophysics, Sound Transmission	W	2
Oc 581	Theoretical Geophysics, Earth Gravity	F	3
Oc 582	Theoretical Seismology	F	3
Oc 583	Earthquake Seismology	Sp	3
Oc 584	Physics of the Earth	W	3

The following Oceanography Courses for Teachers are offered:†

Oc 590	Biological Oceanography for Teachers	Sp, Su	3
Oc 591	Physical Oceanography for Teachers	F, Su	3
Oc 592x	Geological Oceanography for Teachers	Su	3
Oc 593x	Chemical Oceanography for Teachers	Su	3

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*Special Topics in Physical Oceanography

†Credit will not count toward a graduate major in Oceanography

The instructional staff for the courses listed above consists of the following:

Byrne, John V., Ph.D., Department Chairman, Professor, Geological Oceanography
Beardsley, George F., Ph.D., Assistant Professor, Physical Oceanography
Bodvarsson, Gunnar, Ph.D., Professor, Geophysics and Mathematics
Burt, Wayne V., Ph.D., Sc.D., Associate Dean of Research; Professor, Physical Oceanography
Caldwell, Douglas, Ph.D., Assistant Professor, Physical Oceanography
Carey, Andrew G., Jr., Ph.D., Assistant Professor, Biological Oceanography
Couch, Richard, M.S., Instructor, Geophysics
Curl, Herbert C., Jr., Ph.D., Associate Professor, Biological Oceanography
Forster, William O., Ph.D., Assistant Professor, Radioecology
Fowler, Gerald A., Ph.D., Assistant Professor, Geological Oceanography
Frolander, Herbert F., Ph.D., Professor, Biological Oceanography
Gonor, Jefferson J., Ph.D., Assistant Professor, Biological Oceanography
Hedgpeth, Joel W., Ph.D., Professor, Biological Oceanography
Heinrichs, Donald F., Ph.D., Assistant Professor, Geophysics
Kulm, Laverne D., Ph.D., Assistant Professor, Geological Oceanography
Longuet-Higgins, Michael S., Ph.D., Professor, Physical Oceanography
McCauley, James E., Ph.D., Associate Professor, Biological Oceanography
Mesecar, Roderick S., Ph.D., Assistant Professor, Physical Oceanography
Neal, Victor T., Ph.D., Assistant Professor, Physical Oceanography
Neshyba, Stephen J., Ph.D., Associate Professor, Physical Oceanography
Park, P. Kilho, Ph.D., Associate Professor, Chemical Oceanography
Pattullo, June G., Ph.D., Professor, Physical Oceanography
Pearcy, William G., Ph.D., Associate Professor, Biological Oceanography
Pond, G. Stephen, Ph.D., Assistant Professor, Physical Oceanography
Pytkowicz, Ricardo M., Ph.D., Associate Professor, Chemical Oceanography
Renfro, William, Ph.D., Assistant Professor, Radioecology
Small, Lawrence F., Ph.D., Associate Professor, Biological Oceanography
Smith, Robert L., Ph.D., Assistant Professor, Physical Oceanography
Van Andel, Tjeerd H., Ph.D., Professor, Geological Oceanography
Wyatt, Bruce, M.S., Instructor, Physical Oceanography

To obtain further information, address all inquiries directly to:

Dr. John V. Byrne, Chairman
Department of Oceanography
Oregon State University
Corvallis, Oregon 97331

UNIVERSITY OF OREGON
OREGON INSTITUTE OF MARINE BIOLOGY
Eugene, Oregon

The University offers marine biology courses at both its main campus in Eugene and at Oregon Institute of Marine Biology, Charleston, Oregon. A new science building at Eugene includes modern laboratory facilities for biology, chemistry, molecular biology and physics departments.

Oregon Institute of Marine Biology has been in operation for about 30 years and is located on about 85 acres along Coos Bay at Charleston, Oregon. The Institute buildings provide dormitories, dining hall, classrooms, and laboratories. There are six laboratory classrooms, with running salt water, study tables and benches, and lamps. By summer of 1969 five new laboratories are to be completed.

No degrees are offered by the Institute; however, the University of Oregon awards credit, including graduate credit for all courses designated (G), or at the 500 level, for all courses taken at the Institute. Work done at the Institute may form an integral part of the word towards Bachelor's, Master's, or Doctor's degrees in Biology offered on the Eugene campus.

Courses in the marine sciences are offered during the regular year at the main campus by the Department of Biology and Graduate School. The Department of Biology and the Graduate School also offer both regular summer and special workshop courses at the Institute of Marine Biology, Charleston. Independent studies and research have been carried out on a year-round basis at the Institute since 1968.

The following courses will be offered at the Institute during the Summer 1969 session:

Bi 461, 462	Invertebrate Zoology (G)	8
Bi 482	Experimental Invertebrate Embryology (G)	4
Bi 491	Comparative Physiology (G)	4
Bi 401, 501	Research	
Bi 403, 503	Thesis	
Bi 407, 507	Seminar	
Bi 408	Laboratory Projects	

The instructional staff for the courses listed above consists of the following:

Department of Biology

Rudy, Paul P., Ph.D., Acting Director, Oregon Institute of Marine Biology, and Assistant Professor of Biology

Cather, James N., Ph.D., Associate Professor of Biology (Visiting–1969)

McConnaughey, Bayard H., Ph.D., Associate Professor of Biology

Moberly, Walter, Ph.D., Assistant Professor of Biology

Oglesby, Larry C., Ph.D., Assistant Professor of Biology (Visiting–1969)

To obtain further information, address all inquiries directly to:

Dr. Paul P. Rudy, Acting Director
Oregon Institute of Marine Biology
Charleston, Oregon 97420

UNIVERSITY OF THE PACIFIC
Stockton, California

and the

PACIFIC MARINE STATION
Dillon Beach, California

The Pacific Marine Station provides opportunities for study and research in marine biology and related fields of science. The facilities include laboratories, a library, a research museum, darkrooms, and living accommodations. A 34-foot, twin diesel, steel research vessel, BLACK SWAN; a 16-foot Boston Whaler; a 26-foot whaleboat, and various smaller boats are available.

The University offers the degree of **Master of Science**. A minimum of 30 units must be completed for the degree, of which at least 16 must be selected from graduate course offerings in the Department of Biological Sciences (including four units of thesis). The remaining 14 units of course work may be selected from other offerings within the university with approval of the student's graduate committee. Candidates must pass an oral examination in Biology and demonstrate a reading knowledge of at least one of the following: French, German, Russian, or Spanish. An acceptable thesis in the area of the student's major interest is required. For further details consult the Graduate School Bulletin, University of the Pacific.

The following courses are offered by the University in conjunction with the above program. During the academic year there are opportunities for advanced study in problems of marine ecology and invertebrate zoology.

Undergraduate and graduate courses are offered during the summer sessions on a non-matriculation basis. These courses are accepted by many university departments in fulfillment of advanced degree requirements for study at a marine station. Usually three formal courses are offered during the 10 week summer session, all of which are given by visiting instructors from other institutions.

Students from other colleges who desire to study at Pacific Marine Station should plan to begin their program by attending classes at the Station during the summer session before taking up academic year residence at Dillon Beach; formal admission procedures may be deferred until the fall semester.

GRADUATE COURSES (REGULAR SESSION) (PACIFIC MARINE STATION):

213	Advanced Invertebrate Zoology
219	Comparative Histology and Microtechnique
294	Directed Studies
235	Introduction to Oceanography
245	Ecological Physiology
296	Graduate Seminar

GRADUATE AND UNDERGRADUATE COURSES (SUMMER SESSION) (PACIFIC MARINE STATION)

S112	Invertebrate Zoology
S124	Marine Botany (Algology)
S137	Marine Paleontology
S127	Ichthyology

The instructional staff for the courses listed above consists of the following:

Smith, Edmund H., Ph.D., Director, Pacific Marine Station; Associate Professor of Zoology, University of the Pacific

Tucker, John S., Ph.D., Research Associate Professor, Pacific Marine Station; Associate Professor of Natural Science, Raymond College

Marcus, Stanley J., E.M., Associate to the Director, Assistant Professor of Oceanography

Johnson, Ralph G., Ph.D., Adjunct Professor of Paleontology, University of the Pacific (Pacific Marine Station), Associate Professor of Paleontology, University of Chicago

Loosanoff, Victor L., Ph.D., Adjunct Professor of Marine Biology, University of the Pacific (Pacific Marine Station)

Brice, Arthur T., M.A., Adjunct Professor of Microbiology, Phase Contrast, University of the Pacific (Pacific Marine Station)

Underhill, Raymond A., Ph.D., Research Associate (Polychaete development and ecology)

To obtain further information, address all inquiries directly to:

Edmund H. Smith, Director
Pacific Marine Station
Dillon Beach, Marin County, California 94929

UNIVERSITY OF PUERTO RICO
Mayaguez, Puerto Rico

The Department of Marine Sciences was established as the Institute of Marine Biology on the Mayaguez campus of the University of Puerto Rico in 1954. The main offices are located on campus, at present in the former fisheries building but within two years to be moved to a new building being built for marine sciences, geology and physics. The department's marine station is 22 miles to the south on 18-acre Magueyes Island which is about 100 yards offshore from La Parguera. The island is within a broad embayment which is notable for many types of marine habitats. Buildings at the station include a staff laboratory building, an aquarium building with a large classroom and several service buildings. In addition to skiffs, the department operates the 58-foot MEDUSA fitted with basic equipment for oceanographic and marine biological work.

The University offers the degree of **M.S. in Marine Sciences.** All candidates are required to complete a minimum of 30 credit hours of graduate credit. Of these only 6 credits may be in courses open to advanced undergraduate as well as graduate students, and a minimum of 6 credits must be in related courses offered in the graduate programs of other departments. All of the candidates must demonstrate facility in Spanish and English as well as ability to read and translate in one other modern language in which there is sufficient scientific literature in their field of specialization. They must satisfactorily complete a research project, a thesis based on the project, and a comprehensive oral examination.

The following courses are offered in conjunction with the M.S. program:

ADVANCED UNDERGRADUATE AND GRADUATE COURSES

553	Fisheries Biology		3
558	Systematics of Marine Invertebrates	Su	3
564	Ichthyology I		3
595	Marine Ecology	Su	6

GRADUATE COURSES

601	Coastal Geomorphology	3
605	Geology of Deep Ocean Basins	3
611	Coastal Processes	3
618	Oceanographic Hydrodynamics	3
619	Special Problems in Physical Oceanography	1–3
621–622	Marine Sciences	4
625	Marine Microbiology	3
631	Marine Physiology	3
632	Marine Physiology Laboratory	1 or 2
635	Marine Biogeography	3
638	Selected Topics in Physiological Ecology	3
640	Special Problems in Marine Physiology	3
646	Morphology of Marine Invertebrates	3
647	Special Problems in Marine Invertebrates	1–3
648	Marine Invertebrate Embryology	3
652	Biological Oceanography	3
653	Special Problems in Fisheries Biology	1–3
661	Marine Botany	3
662	Special Problems in Marine Algae	1–3
665	Ichthyology II	3
666	Special Problems in Ichthyology	1–3
668	Pigment Physiology	3
671	Instrumental Methods in Marine Sciences	3
681	Ecology of Marine Communities	2
691–692	Graduate Seminar	1
695	Special Problems	1–3
699	Research	Up to 6

The instructional staff for the courses listed above consists of the following:

Department of Marine Sciences

Cerame-Vivas, Maximo J., Ph.D., Director and Associate Professor
Almodóvar, Luis R., Ph.D., Professor
Burkholder, Paul H., Ph.D., Professor
Cutress, Charles E., M.S., Associate Professor
Eger, William H., M.S., Assistant Professor
Giese, Graham S., Ph.D., Assistant Professor
Glynn, Peter W., Ph.D., Associate Professor
González, Juan G., M.S., Assistant Professor
Maddux, William S., Ph.D., Assistant Professor
Ting, Robert Y., Ph.D., Associate Professor
Tosteson, Thomas R., Ph.D., Associate Professor
Zeigler, John M., Ph.D., Professor

To obtain further information, address all inquiries directly to:

Dr. Máximo J. Cerame-Vivas, Director
Department of Marine Sciences
University of Puerto Rico
Mayaguez, Puerto Rico 00708

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island

The Graduate School of Oceanography, maintains a group of laboratories, offices and support facilities at the Narragansett Bay Campus, a waterfront location in Narragansett, R. I. Principal structures are the Charles J. Fish Oceanographic Laboratory, a new 30,000 square foot laboratory and the Claiborne Pell Marine Science Library, the latter two completed in 1968. The graduate school operates R/V TRIDENT, a 180-foot research vessel, and a number of small craft.

The University offers the degrees of **Master of Science in Oceanography** and **Doctor of Philosophy in Oceanography**. Both degrees are given with options in biological, chemical, geological, and physical oceanography.

The following courses in the marine sciences are offered in conjunction with these programs. In addition, graduate students in oceanography may choose from supporting courses in other departments of the University.

100	General Oceanography
201	Physical Oceanography
210	Descriptive Physical Oceanography
211	Geophysical Hydrodynamics
213	Waves
221	Chemical Oceanography
225	Organic Geochemistry
230	Geochemistry
231	Seminar in Marine Geochemistry
240	Geological Oceanography
243	Seminar in Deep-Sea Geology
244	Thermodynamics of the Earth's Interior
245	Geology of Continental Margins
247	Recent Sedimentary Environments
261	Biological Oceanography
264	Phytoplankton
266	Zooplankton
267	Marine Bacteriology
268	Fishery Biology
271	The Benthic Environment
272	Marine Invertebrates and Environment
273	Advanced Animal Behavior
274	Biology of Marine Mammals
291, 292	Individual Study
293, 294	Special Studies
361	Ecological Concepts in Marine Research
391	Seminar in Oceanography

The University also offers a graduate program in ocean engineering and an associate program in fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Knauss, John A., Ph.D., Dean, Professor and Provost for Marine Affairs
Marshall, Nelson, Ph.D., Professor
Pratt, David M., Ph.D., Professor
Saila, Saul B., Ph.D., Professor
Sieburth, John McN., Ph.D., Professor
Stern, Melvin E., Ph.D., Professor
Winn, Howard E., Ph.D., Professor
Jeffries, Perry H., Associate Professor
Krause, Dale C., Associate Professor

McMaster, Robert L., Ph.D., Associate Professor
Smayda, Theodore J., Dr., Philos., Associate Professor
Diamantis, Basil, Ph.D., Assistant Professor
Kenyon, Kern, Ph.D., Assistant Professor
Lambert, Richard B., Ph.D., Assistant Professor
Napora, Theodore A., Ph.D., Assistant Professor and Assistant Dean for Students
Pilson, Michael E., Ph.D., Assistant Professor
Quinn, James G., Ph.D., Assistant Professor
Sastry, Akella N., Ph.D., Assistant Professor
Schilling, Jean-Guy, Ph.D., Assistant Professor
Sturges, Wilton III, Ph.D., Assistant Professor
Swift, Elijah, Ph.D., Assistant Professor
LaRoche, Gilles, Ph.D., Adjunct Professor
Shuster, Carl N., Ph.D., Adjunct Professor

To obtain further information, address all inquiries directly to:

Dr. John A. Knauss, Dean, Professor and Provost for Marine Affairs

Dr. Theodore A. Napora, Assistant Professor and Assistant Dean for Students

University of Rhode Island
Kingston, Rhode Island 02881

RUTGERS UNIVERSITY
New Brunswick, New Jersey

The University does not offer programs in oceanography or marine sciences as such but does offer marine oriented courses in biology, engineering, and geology at the three campuses, New Brunswick, Newark and Camden. The classroom facilities are typical for the three sciences mentioned. There are three off-campus facilities for biology research at the graduate level: a converted Coast Guard station for the study of purifying hard shell clams at Monmouth Beach; a laboratory and compound for studying oyster production near Cape May on the Delaware Bay; and a small houseboat for studying estuarine ecology in Mullica Bay.

The following degrees are offered:

1. **B.S.**–general preparation for research and graduate studies in marine science.
2. **M.S.** in Aquatic Biology (salt and fresh water), Aquatic Weed Control, Environmental Radioactivity, Marine and Estuarine Ecology, Marine Microbiology, Marine Nematology, Meteorology (general), Soil and Water Chemistry, Stream and Estuary Sanitation, Water Pollution, Water Resources, Water-based Recreation.
3. **Ph.D.** in Aquatic Biology (salt and fresh water), Aquatic Weed Control, Environmental Radioactivity, Marine and Estuarine Ecology, Marine Microbiology, Marine Nematology, Soil and Water Chemistry, Stream and Estuary Sanitation, Water Pollution, Water Resources, Water-based Recreation.

The following courses are offered in conjunction with the above programs:

Field of Biology

375:403	Air and Water Environment
375:404	Aquatic Biology
375:444	Water Resources
375:505	Stream Sanitation
375:510	Microbiology of Water
375:511	Ichthyology
375:512	Fishery Management
990:406	Limnology
990:504	Elements of Oceanography
990:506	Ecology of the Estuary
120:415	Marine Ecology
130:411	Algae: Morphology and Taxonomy
130:513	Algae: Biology and Physiology

Department of Geology

450:401	Ocean Basins

The instructional staff for the courses listed above consists of the following:

College of Agriculture

Faust, J. D., Dr. (Environmental Science)
Havens, A. V., Professor (Meteorology)
Pramer, D., Dr. (Microbiology)
Westman, J. R., Dr. (Environmental Science)

Department of Botany

Moul, E. T., Dr.

Department of Geology

Fox, S. K., Dr.
Johnson, H., Dr.
Murrary, R. C., Dr.
Olsson, R. K., Dr.

Department of Zoology

- Haskin, H., Dr.
- Loveland, R., Dr.
- McDowell, S. B., Dr.
- Stauber, L., Dr.

To obtain further information, address all inquiries directly to:

Chairman of the All-University Committee on Oceanography

Dr. Walter A. Maclinn, Director
New Jersey Agricultural Experiment Station
Rutgers University–The State University of New Jersey
New Brunswick, New Jersey 08903

SACRAMENTO STATE COLLEGE
Sacramento, California

The college offers marine science courses on the Sacramento campus in the Departments of Biological Sciences and Physics–Physical Sciences (as part of the curricula in environmental biology and geology, respectively). The college also participates in the operation of the Moss Landing Marine Laboratories in Moss Landing, California (on Monterey Bay), as part of a consortium of five California State Colleges described in the **Consortia** section. The science departments at the college occupy a five-story science building completed in 1967; the Biological Sciences Department occupies approximately one-and-one-half floors of space in this large building, as well as retaining the two-story building occupied earlier; these aggregate about 69,000 sq. ft. of floor space, 45,000 in the larger building and 24,000 in the smaller. The Physics-Physical Sciences Department takes up approximately one-and-a-half stories of space. Laboratories are modern and functional. The Biological Sciences Department maintains a 23-foot research inboard power cruiser and several smaller boats and the science building has salt water facilities. The Sacramento campus is located within an hour's drive of estuarine environments and within two hour's drive of the Pacific Ocean.

The following degrees are offered:

1. **B.A. in Biological Sciences.** A broad based, normal 124 semester-unit baccalaureate degree. Chemistry, physics, mathematics and statistics required as supporting subjects. For the marine sciences specialty–Bio. Sci. 150, 162, 163 and Geology 101 are specified and Bio. Sci. 173 is recommended.

2. **B.S. in Biological Sciences (Biological Conservation (Fish and Game)).** This is a 132 semester-unit degree, which consists of the basic biology curriculum, with the addition of certain fish and game and other conservation courses.

3. **M.A. in Biological Sciences.** Students take several required courses in biological sciences, as well as supporting courses. A thesis is required. Certain courses and the thesis research can be done at Moss Landing Marine Laboratories.

The following courses are offered in conjunction with the above programs:

Department of Biological Sciences:

162	Ichthyology	F	3
163	Marine Ecology	F	3
173	Principles of Fisheries Biology	F	3
273	Advanced Fishery Biology	Sp	3
196	Proseminar	F	2
296	Seminar	Sp	2
199/299	Special Problems	F or Sp	2
500	Master's Thesis	F or Sp	2–4

Department of Physics–Physical Sciences:

Geology:

101	General Oceanography	Sp	3
196	Seminar	F or Sp	1–4
199	Special Problems	F or Sp	1–3

Moss Landing Marine Laboratories offers approximately a dozen courses in this field, as well as seminars, workshops, and research.

The instructional staff for the courses listed above consists of the following:

Department of Biological Sciences

Brittan, Martin R., Ph.D., Professor of Biological Sciences
Meeker, Gary L., Ph.D., Assistant Professor of Biological Sciences
Schinske, Robert, M.S., Associate Professor of Biological Sciences
Vanicek, C. David, Ph.D., Assistant Professor of Biological Sciences

Department of Physics-Physical Sciences

Janke, Norman C., Ph.D., Associate Professor of Physical Sciences

To obtain further information, address all inquiries directly to:

Chairman, Department of Biological Sciences
Sacramento State College
Sacramento, California 95819

SALEM STATE COLLEGE
Salem, Massachusetts

Present facilities at Salem include classroom and laboratory facilities in the Arts and Science building on campus. A new science wing to this building is presently under construction.

No degrees are presently specifically offered in the marine sciences. Students in the Liberal Arts Program may major in biology and select from among the following marine science courses:

BI 320	General Ecology	F	4
BI 322	Oceanology	Sp	4
BI 317	Marine Botany	Su	4
BI 318	Marine Ecology	Su	4

The instructional staff for the courses listed above consists of the following:

Department of Biology

Moore, Johnes K., Ph.D., Assistant Professor of Biology
Paine, Claire M., Ph.D., Associate Professor of Biology
Schooley, James B., Ph.D., Professor of Biology
Sweeny, Edward F., Ph.D. (exp. 1969), Associate Professor of Biology
Sullivan, Frank L., M.A., Assistant Professor of Biology
Terrell, Charles R., M.S., Instructor

To obtain further information, address all inquiries directly to:

Professor Thomas I. Ryan, Chairman
Department of Biology
Salem State College
Salem, Massachusetts 01970

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SAN DIEGO STATE COLLEGE
San Diego, California

Marine sciences course and research programs are conducted primarily at the main campus, located 10 miles from the coast. Docking facilities are maintained in Mission Bay. Active course and research programs in the marine sciences are coordinated by an interdisciplinary Bureau of Marine Sciences. All departments have modern, well-equipped classroom, laboratory, and shop facilities. Provisions for marine instruction and research include standard physical and biological oceanographic equipment, laboratories for the analysis of sea water and sediment characteristics, radioisotope and electron microscope facilities, constant temperature rooms, and closed-system sea water aquaria. Computer facilities are available on the campus. Library holdings are well represented in the marine sciences and the extensive marine sciences library of the Scripps Institution is readily accessible. Several small craft, one equipped with a fathometer and hydrographic winch, are available for coastal sampling operations. The use of oceanographic vessels and other specialized facilities can be arranged in cooperation with the Scripps Institution of Oceanography and the Fishery-Oceanography Center of the U. S. Bureau of Commercial Fisheries.

The following degrees are offered in the basic sciences:

1. **A.B. and B.S. in Biology, Botany, Chemistry, Geology, Physics, and Zoology; B.S. in Engineering**

All students are required to fulfill the general education requirements of the college and to complete a series of core courses in their major field and in related areas of science and mathematics. Students are encouraged to obtain practical research experience through senior investigation and special studies courses.

2. **M.A. and M.S. in Biology, Chemistry, and Physics; M.S. in Geology and Engineering disciplines**

All students are required to obtain research experience and to demonstrate competence in their major field by satisfactorily completing a comprehensive examination and a thesis project. A student must complete 30 semester units of graduate course work with a grade point average of 3.0 (B) or better in order to qualify for the degree.

3. **Ph.D. in Chemistry (offered jointly with the University of California, San Diego)**

In order to qualify for this program, the student must be admitted to regular graduate standing by the University of California and San Diego State College. He must be prepared to take orientation examinations covering the fields of analytical, inorganic, organic, and physical chemistry, administered by a joint guidance committee. After formal admission to the program, the student must spend at least one year in full-time residence on each of the two campuses. A dissertation on a subject chosen by the student bearing on his field of specialization and showing his ability to conduct independent research is required of all candidates. A reading knowledge of two foreign languages also is required. A joint doctoral committee, consisting of three faculty members from each institution, conducts the qualifying and final oral examinations and guides the thesis research. The degree is awarded jointly by both institutions.

Courses in the marine sciences are offered during the regular academic year by the Departments of Biology, Botany, Chemistry, Engineering, Geology, Physical Science, Physics, and Zoology. Students are encouraged to specialize by taking marine science courses, and an interdisciplinary course sequence is being developed for this purpose under the auspices of the Bureau of Marine Sciences.

The following courses are offered in conjunction with the above programs:

UNDERGRADUATE COURSES

Department of Biology

109	Regional Field Studies in Biology	Su	1–3
110	Ecology	F, Sp	4
112	Fisheries Biology	Sp	3
113	Biological Oceanography	F, Sp	4
114	Advanced Ecology	F, Sp	3
175	Statistical Methods in Biology	F	3

Department of Biology*—Continued*			
191	Senior Investigation & Report in Ecology		2
198	Methods of Investigation		2
199	Special Study		1–6
Department of Botany			
101	Phycology	F, Sp	4
190	Senior Investigation and Report		1
199	Special Study		1–6
Department of Zoology			
105	Invertebrate Embryology		3
112	Marine Invertebrate Zoology	F, Sp	4
115	Ichthyology	F, Sp	4
150	Marine Biology	F, Sp	3
170	Animal Behavior	F, Sp	3
190	Senior Investigation & Report in Invertebrate Zoology		2
191	Senior Investigation & Report in Vertebrate Zoology		2
198	Methods of Investigation		2
199	Special Study		1–6
Department of Chemistry			
196	Selected Topics in Chemistry		1–3
198	Senior Project		1–6
199	Special Study		1–6
Department of Geology			
198	Senior Research		3
199	Special Study		1–4
Department of Oceanography			
100	The Oceans	F, Sp	2
Department of Physical Science			
110	Physical Oceanography	F, Sp	3
170A–B	Theoretical Oceanography	F, Sp	3, 3
196	Advanced Physical Science	F, Sp	1–3
199	Special Study		1–6
Department of Physics			
198	Senior Research		1
199	Special Study		1–6
Department of Engineering			
181	Hydrodynamics		3
GRADUATE COURSES			
Department of Biology			
241	Seminar in Aquatic Ecology		2
245	Aquatic Ecology		3
291	Investigation and Report		3
297	Research		1–6
298	Special Study		1–6
299	Thesis		3
Department of Botany			
200	Seminar		2
297	Research		1–6
298	Special Study		1–6
299	Thesis		3

Department of Zoology

200	Seminar	2–3
201	Seminar in Marine Zoology	2
206	Seminar in the Biology of Cold-blooded Vertebrates	2
212	Advanced Marine Invertebrate Zoology	3
291	Research Techniques	3
297	Research	1–6
298	Special Study	1–6
299	Thesis	3

Department of Chemistry

200	Seminar	1–3
291	Research Seminar	1
297	Research	1–6
298	Special Study	1–6
299	Thesis	3

Department of Geology

200	Seminar	2–3
297	Research	1–6
298	Special Study	1–3
299	Thesis	3

Department of Physical Science

200	Seminar in Physical Oceanography	2–3
298	Special Study	1–6
299	Thesis	3

Department of Physics

200	Seminar	2–3
297	Research	1–6
298	Special Study	1–6
299	Thesis	3

Department of Engineering

CE235	Water Quality Engineering	3
CE236	Water Quality Processes I	3
CE237	Water Quality Processes II	3
CE283	Seminar in Hydraulic Engineering	2–3
CE284	Seminar in Sanitary Engineering	2–3

The instructional staff for the courses listed above consists of the following:

Division of Life Sciences

Darby, Richard L., Ph.D., Assistant Professor of Biology
Dexter, Deborah M., Ph.D., Assistant Professor of Zoology
Farris, David A., Ph.D., Professor of Biology
Ford, Richard F., Ph.D., Associate Professor of Biology
Gallup, Avery H., Ph.D., Professor of Botany
Hazen, William E., Ph.D., Professor of Biology
Huffman, Edward W., Ph.D., Professor of Zoology
McBlair, William, Ph.D., Professor of Biology
McLean, Norman, Ph.D., Associate Professor of Zoology
Todd, John, Ph.D., Assistant Professor of Zoology
Wilson, Wilfred J., Ph.D., Associate Professor of Zoology

Division of Physical Sciences

Allison, Edwin C., Ph.D., Professor of Geology
Berger, Wolfgang, Ph.D., Assistant Professor of Physical Science
Berry, Richard W., Ph.D., Associate Professor of Geology

Division of Physical Sciences–*Continued*

Dessel, Norman F., Ph.D., Professor of Physical Sciences
Dill, Robert F., Ph.D., Lecturer in Biology
Ingmanson, Dale, Ed.D., Assistant Professor of Physical Science
Mathewson, James H., Ph.D., Associate Professor of Chemistry
Moe, Chesney R., Ph.D., Professor of Physics
Phleger, Charles, Ph.D. candidate, Assistant Professor of Physical Science
Riffenburgh, Robert, Ph.D., Professor of Physical Science

School of Engineering

Chang, Hai-Yain, Ph.D., Assistant Professor of Aerospace Engineering
Morgan, Chalres, M.S., Professor of Mechanical Engineering
Noorany, Irag, Ph.D., Professor of Civil Engineering
Quiett, Frederick T., M.S., Professor of Civil Engineering
Stratton, Frank E., Ph.D., Associate Professor of Civil Engineering

To obtain further information, address all inquiries directly to:

Director, Bureau of Marine Sciences
San Diego State College
5402 College Avenue
San Diego, California 92115

SAN FRANCISCO STATE COLLEGE
San Francisco, California

Classroom and laboratory facilities are available at the main campus in San Francisco for studies in invertebrate and vertebrate zoology, marine botany, and marine microbiology. There are also facilities for graduate studies in ecology, functional morphology, systematics, physiology, and ethology. The College enjoys a close working relationship with the nearby California Academy of Sciences where qualified students may take advantage of the valuable library and the large collections of fishes, invertebrates, and other materials for studies in systematics and morphology. San Francisco State College, in cooperation with four other California State Colleges, operates Moss Landing Marine Laboratory as a sea-side campus extension (for a detailed description of the Moss Landing facilities, refer to the **Consortia** section).

The college offers an **M.A. in Biology with a concentration in Marine Biology** through the Department of Marine Biology. Each student is required to complete a total of thirty (30) semester units, selected with the approval of a marine biology advisor. Courses are to consist of upper division and graduate courses with a minimum of twelve (12) units of graduate courses. At least one course must be taken at an approved marine station. Of graduate courses, at least two must be seminar courses. A minimum of three (3) (maximum of six (6)) units of research courses is required. A thesis is required (an oral or written examination may be substituted in exceptional cases) for which a student may take a maximum of six (6) thesis research units.

The following courses are offered in conjunction with the above program:

Department of Marine Biology

Biol. 111	Biological Oceanology	Sp	3
Biol. 141	Introductory Fishery Biology	F	4
Biol. 165	Marine Science Diver Training		2
Biol. 187	Marine Zoogeography	Sp	2
Bot. 107	Algology	Sp	4
Geog. 115	Oceanography	F	3
Geog. 116	The Geography of Marine Resources		3
Zool. 113	Marine Invertebrate Zoology	F	4
Zool. 114	Natural History of the Marine Invertebrates	Sp	4
Zool. 115	Marine Invertebrate Physiology	F	3
Zool. 160	Introductory Ichthyology	F	3
Zool. 223	Ecology of Estuaries and Lagoons		3

The instructional staff for the courses listed above consists of the following:

Department of Geography

Eydal, Astvaldur, Ph.D., Associate Professor of Geography

Department of Marine Biology

Beeman, Robert D., Ph.D., Associate Professor of Biology and Chairman of the Department
Araki, George S., Ph.D., Associate Professor of Biology
Berrend, Robert E., Ph.D., Associate Professor of Biology
Bowen, Sarane T., Ph.D., Associate Professor of Biology
Bradbury, Margaret G., Ph.D., Associate Professor of Biology
Gustafson, Joel F., Ph.D., Professor of Biology
Hensill, John S., Ph.D., Professor of Biology and Dean of the School of Natural Sciences
Herald, Earl S., Ph.D., Lecturer in Biology
Newcombe, Curtis L., Ph.D., Professor of Biology
Oberlander, George T., Ph.D., Professor of Biology
Swan, Lawrence W., Ph.D., Professor of Biology
Tomlinson, Jack T., Ph.D., Professor of Biology
Towle, Albert, Ph.D., Professor of Biology

Department of Marine Biology–*Continued*

Treichel, Georg, B.A., Lecturer in Human Ecology
Zullo, Victor A., Ph.D., Lecturer in Biology

Department of Microbiology

Yonemaka, Hideo H., Ph.D., Associate Professor of Biology

To obtain further information, address all inquiries directly to:

Chairman, Department of Marine Biology
San Francisco State College
1600 Holloway Ave.
San Francisco, California 94132

SAN JOSE STATE COLLEGE
San Jose, California

Classes are conducted both on the main campus in San Jose and at the seashore station, The Moss Landing Marine Laboratories (a description of the Moss Landing facilities can be found in the **Consortia** section). A science building housing the geology, meteorology, chemistry and physical science departments was completed in 1967. Facilities on the geology floors include 2 geophysics laboratories, one sedimentation and one micropaleontology laboratory. Mineralogy laboratory and equipment are also at the disposal of students both for research and teaching purposes. A new science building for biological sciences will be completed in 1970. A separate map room with complete coverage of the ocean floor and a collection room for samples and cores for study of ocean floor sediments are also part of the facility. The computing center has also been under continuous expansion; a new Control Data 3300 computer has been installed and will boost the computing facilities which are available both for faculty and student research.

The following degrees are offered in the areas indicated:

1. **Bachelor of Science with option in Oceanography**
2. **Master of Science** (thesis required)

Students may specialize in any of the following fields: Geophysics, Geochemistry, Geological, Chemical, or Biological Oceanography.

An interdisciplinary approach to oceanography is emphasized in the undergraduate and graduate training programs. At the undergraduate level, training is done through oceanography options for each regular science major, e.g., chemistry, geology, biology, etc. At the graduate level, training is tailored to the student for the Master's Degree; theses are required.

The following courses are offered in conjunction with the above programs (all specialized courses are upper division and graduate courses):

Geol. 129	General Oceanography	4
Geol. 111	Geophysics	3
Geol. 115	Geochemistry	3
Geol. 113	Micropaleontology	3
Geol. 141	Geological Oceanography	4
Geol. 142	Marine Biogenic Sediments	3
Geol. 143	The Margin of the Oceans	2
Geol. 196	Marine Science Techniques	1
Biol. 111	Zoology of Marine Vertebrates	4
Biol. 121	Marine Invertebrate Zoology	4
Biol. 131	Marine Algology	3
Biol. 141	Biological Oceanography	3
Biol. 161	Marine Ecology	3
Biol. 181	Literature of the Marine Sciences	1
Chem. 141	Chemical Oceanography	3
Phys. 141	Physical Oceanography	3
Meteo. 135	Meteorology of the Oceans	3

The instructional staff for the courses listed above consists of the following:

Biology Department

Bell, Charles, Ph.D., Associate Professor of Biology
Harville, John, Ph.D., Professor of Biology and Marine Science
Kenk, Vida, M.S., Assistant Professor
McMaster, Pauline, M.A., Associate Professor of Invertebrate Zoology
Morejohn, Victor, Ph.D., Professor of Biology

Chemistry Department

Stump, Arthur, Ph.D., Assistant Professor of Chemical Oceanography

Geology Department

Arnal, Robert E., Ph.D., Professor of Geology
Brooke, John P., Ph.D., Assistant Professor of Geophysics
Dolloff, Norman H., Ph.D., Professor of Geology
Stevens, Calvin H., Ph.D., Associate Professor of Geology

Meteorology Department

Miller, Albert, Ph.D., Professor of Meteorology
Read, Robert, M.S., Associate Professor of Marine Meteorology

To obtain further information, address all inquiries directly to:

Dr. Robert E. Arnal (for physical sciences)
Geology Department
San Jose State College
San Jose, California 95114

Dr. John Harville (for biological sciences)
Biology Department
San Jose State College
San Jose, California 95114

Moss Landing Marine Lab.
P. O. Box 223
Moss Landing, California 95039

SCRIPPS INSTITUTION OF OCEANOGRAPHY
UNIVERSITY OF CALIFORNIA, SAN DIEGO
La Jolla, California

Since 1912 the Scripps Institution of Oceanography has been a unit of the University of California. Now part of the University of California San Diego campus, the nine buildings of the Scripps Institution are clustered on the ocean shore north of the center of La Jolla, a suburb of San Diego. The SIO Library, a unit of the University Library, contains more than 70,000 volumes, 87,000 reports and reprints, 3,000 serials, and a large collection of charts. Special facilities are as follows: Radio station WWD, operated by the U. S. Bureau of Commercial Fisheries; the Scripps Pier, 1,000 feet long, housing apparatus for a number of serial oceanographic observations, and used as a landing place for skiffs; the salt water system providing clean sea water to the aquarium and biological laboratories; an underwater area for research and collecting offshore from the Institution; deep-sea sediment cores from several thousand widely scattered localities in the world ocean; original echograms along several thousand widely scattered localities in the world ocean; original echograms along several hundred thousand miles of ships' tracks in the Pacific; Carbon-14 and tritium laboratories; an oceanographic data archive of some half a million bathythermograph (BT) observations; an electron microprobe laboratory; six mass spectrographs; several thousand samples of sea water from the world oceans; an electron microscope laboratory; the Scripps fish collection of more than 750,000 specimens of some 2,000 species of marine fish; oceanic samples of plankton. Scripps scientists have access to the University's computer center. The Institution operates eight ships specially fitted for oceanographic research: ALEXANDER AGASSIZ, ARGO, FLIP (Stable research platform), ALPHA HELIX, OCONOSTOTA, E. B. SCRIPPS, WASHINGTON, MELVILLE.

Scripps offer the degrees of **Ph.D. in Oceanography, Ph.D. in Marine Biology, and Ph.D. in Earth Sciences.** The program of study for the Ph.D. degree is determined in consultation with the student's adviser. The Department has no formal language requirements. Students are expected to have satisfied the entrance requirement of preparation in at least one important language. Within the Department, curricular programs may require demonstration of ability to use certain foreign languages pertinent to a student's research. All students are normally required to take a departmental examination, and the student will be required to demonstrate his comprehension of required subject material and of the pertinent interactions of physical, chemical, biological or geological, factors. After the student has passed the departmental examination, and has completed an appropriate period of additional study the Department will recommend appointment of a doctoral committee. This committee will determine the student's qualifications for independent research by means of a Qualifying Examination and will supervise the student's performance and reporting of his research. A requirement for the Ph.D. degree is the submission of a dissertation and a final examination in which the thesis is publicly defended.

The Department does not encourage students who wish to proceed only to the M.S. If circumstances warrant, the degree is normally offered under Plan II (comprehensive examination) after completion of course work established by the department.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

Upper-Division Courses			
199	Special Studies	F, W, Sp	1–4
Graduate Courses			
207A, B	Problems in General and Physical Oceanography	W, Sp	2, 2
208	Oceanography Field Course	F, W, Sp, Su	2–4
209	Special Topics	F, W, Sp	1–4
210A	Physical Oceanography	F	3
210B	Physical Oceanography	W	3
211A, B	Ocean Waves	W, Sp	3, 3
212A	Dynamical Oceanography	F	3
212B	Dynamical Oceanography	Sp	3

Graduate Courses–*Continued*

213A, B	Radiative Transfer in the Sea	F, W	2–3
216A, B	Physics of Sediment Transport	W, Sp	3, 3
219	Special Topics in Physical Oceanography	F, W, Sp	1–4
220	Topics in Geophysical Continuum Mechanics	F	3
221	Topics in Geophysical Fluid Dynamics	W	3
222A, B	Hydrodynamics	W, Sp	3, 3
223	Geophysical Measurements	Sp	3
224	Geophysical Random Processes	Sp	3
225	Tides and the Rotation of the Earth	W	3
226A, B	Internal Constitution of the Earth	W, Sp	3, 3
227	Seismology	Sp	3
228	Gravity and Geomagnetism	W	3
240	Marine Geology	W	3
242A, B	Marine Micropaleontology	W, Sp	3, 3
243	Marine Stratigraphy	Sp	3
244	Marine Geophysics	W	3
245	Sedimentary Petrology	F	3
246	Minerals and Processes of Sediments	W	3
247	Tectonics	Sp*	3
248	Seminar in Marine Geology	F, W, Sp	2
249	Special Topics in Marine Geology	F, W, Sp	1–4
251A	Thermodynamics of Natural Processes	Sp*	3
251B	Nuclear Geochemistry	W*	3
252	Cosmochemistry	F*	3
253	Experimental Petrology	F	3
254	Igneous Petrology	W*	3
255	Crustal Evolution	Sp*	3
256	Earth Sciences Summer Field Course	Su	6
257	Seminar in Petrology	F, W, Sp	3
258	Seminar in Geology	F, W, Sp	3
259	Seminar in Geochemistry	F, W, Sp	3
260	Marine Chemistry	F	3
261	Physical Chemistry of Sea Water	F	3
262	Major Sedimentary Cycle	W	3
263	Major Chemical Cycles in the Sea	Sp	3
264	Solids in Nature	Sp*	3
269	Special Topics in Marine Chemistry	F, W, Sp	1–4
270A	Biological Oceanography: Environment and Organisms	F	3
270B	Biological Oceanography: Processes and Events	W	3
271A	Laboratory in Biological Oceanography	F	2
271B	Laboratory in Biological Productivity	W	2
272	Oceanic Zoogeography	Sp*	3
273	Introduction to Animal Behavior	F	3
274	Population Dynamics	F*	3
275A, B	Marine Ecology	W, Sp*	3, 3
276A, B	Applied Statistics	W, Sp*	3, 3
278	Problems in Biological Oceanography	F	2
279	Special Topics in Biological Oceanography	F, W, Sp	1–4

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*Offered in alternate years.

Graduate Courses–*Continued*

280A, B	Marine Biology	F, W, Sp	3, 3, 3
282A, B	Advanced Invertebrate Zoology	F, W	3, 3
283	Biology of Fishes	Sp	4
284	Seminar in Advanced Ichthyology	F, W	2
285	Biology of Algae	F	2
286	Marine Microbiology	F	3
287A, B	Shore Microbiology	W, Sp	3, 3
289	Special Topics in Marine Biology	F, W, Sp	1–4
290	Cellular Structure and Biochemical Function	Sp	3
291A	Marine Biochemistry	W	3
291B	Marine Biochemistry	Sp	3
292A, B	Physiology of Marine Animals	W, Sp	3, 3
293	Physiology of Marine Algae	F	3
294	Selected Topics in Environmental Physiology	F	6
295	Laboratory in Physiology	Sp	4
296	Isotope Tracer Techniques in Physiology	Sp	2
298	Marine Biology Seminar	F, W, Sp	1
299	Research	F, W, Sp	1–12

The instructional staff for the courses listed above consists of the following:

Winterer, Edward L., Ph.D., Chairman and Professor of Geology
Arrhenius, Gustaf, D.Sc., Professor of Marine Geology
Arthur, Robert S., Ph.D., Professor of Oceanography
Backus, George E., Ph.D., Professor of Geophysics
Benson, Andrew A., Ph.D., Professor of Biology
Brinton, Edward, Ph.D., Lecturer in Oceanography
Bullard, Edward C., F.R.S., Sc.D., Professor of Geophysics
Bullock, Theodore H., Ph.D., Professor of Neurophysiology
Cox, Charles S., Ph.D., Professor of Oceanography
Craig, Harmon, Ph.D., Professor of Geochemistry
Curray, Joseph R., Ph.D., Associate Professor of Oceanography
Davis, Russ E., Ph.D., Assistant Professor of Geophysics
Duntley, Seibert Q., Ph.D., Professor of Physics
Eckart, Carl H., Ph.D., Professor of Geophysics
Engel, Albert E. J., Ph.D., Professor of Geology
Enns, Theodore, Ph.D., Lecturer in Marine Biology
Enright, James T., Ph.D., Associate Professor of Oceanography
Fager, Edward W., Ph.D., D. Phil., Professor of Marine Ecology
Faulkner, David J., Ph.D., Assistant Professor of Oceanography
Fisher, Frederick H., Ph.D., Lecturer in Marine Chemistry
Fleminger, Abraham, Ph.D., Lecturer in Marine Biology
Fox, Denis L., Ph.D., Professor of Marine Biochemistry
Gibson, Carl H., Ph.D., Assistant Professor of Aerospace Engineering
Gieskes, Joris M. T., Ph.D., Assistant Professor of Oceanography
Gilbert, J. Freeman, Ph.D., Professor of Geophysics
Goldberg, Edward D., Ph.D., Professor of Chemistry
Hagiwara, Susumu, M.D., Ph.D., Professor of Physiology
Hammel, Harold T., Ph.D., Professor of Physiology
Haubrich, Richard A., Ph.D., Associate Professor of Geophysics
Hawkins, James W., Ph.D., Assistant Professor of Geology
Haxo, Francis T., Ph.D., Professor of Biology
Hendershott, Myrl, Ph.D., Assistant Professor of Oceanography
Hessler, Robert R., Ph.D., Associate Professor of Oceanography

Holland, Nicholas D., Ph.D., Assistant Professor of Marine Biology
Inman, Douglas L., Ph.D., Professor of Oceanography
Isaacs, John D., B.S., Professor of Oceanography
Keeling, Charles D., Ph.D., Professor of Oceanography
Lewin, Ralph A., Ph.D., Professor of Biology
MacIntyre, Ferren, Ph.D., Assistant Professor of Oceanography
McGowan, John A., Ph.D., Associate Professor of Oceanography
Menard, Henry W., Ph.D., Professor of Geology
Mullin, Michael M., Ph.D., Assistant Professor of Oceanography
Munk, Walter H., Ph.D., Professor of Geophysics
Newman, William A., Ph.D., Assistant Professor of Oceanography
Nierenberg, William A., Ph.D., Professof of Physics, Dean and Director, Scripps Institution of Oceanography
Owen, Benton B., Ph.D., Lecturer in Marine Chemistry
Parker, Robert L., Ph.D., Assistant Professor of Geophysics
Peterson, Melvin N. A., Ph.D., Associate Professor of Oceanography
Phleger, Fred B., Ph.D., Professor of Oceanography
Preisendorfer, R. W., Ph.D., Lecturer in Geophysics
Raitt, Russell W., Ph.D., Professor of Geophysics
Reid, Joseph L., M.S., Lecturer in Oceanography
Riedel, William R., M.S., Lecturer in Oceanography
Rosenblatt, Richard H., Ph.D., Associate Professor of Marine Biology; Vice-Chairman
Schaefer, Milner B., Ph.D., Professor of Oceanography
Scholander, Per F., M.D., Ph.D., Professor of Physiology
Shor, George G., Jr., Ph.D., Lecturer in Oceanography
Spiess, Fred N., Ph.D., Professor of Oceanography
Strickland, John D. H., Ph.D., Lecturer in Oceanography
Taft, Bruce A., Ph.D., Assistant Professor of Oceanography
Vacquier, Victor, M.A., Professor of Earth Sciences
Van Atta, Charles W., Ph.D., Assistant Professor of Aerospace Engineering
Wooster, Warren S., Ph.D., Professor of Oceanography
Volcani, Benjamin A., Ph.D., Professor of Microbiology
ZoBell, Claude E., Ph.D., Professor of Marine Microbiology

To obtain further information, address all inquiries directly to:

Graduate Department
Scripps Institution of Oceanography
Box 109
La Jolla, California 92037

UNIVERSITY OF SOUTHERN MISSISSIPPI
Hattiesburg, Mississippi

The Department of Biology offers a variety of courses which cover both marine biology and biological oceanography. Currently the department operates in an area of 35,000 square feet representing both labs and classrooms. The University is closely affiliated with the Gulf Coast Research Laboratory at Ocean Springs, Mississippi (only 90 miles away). This association allows use of the research vessels HERMES and GULF RESEARCHER which belong to GCRL. The department also utilizes the facilities of the Bureau of Commercial Fisheries' vessel, R/V OREGON II, on a space available basis.

The Department of Geology, which occupies 18,000 square feet of laboratories, offices, and classrooms in the Science Building also cooperates closely with the GCRL and is extended the use of GCRL facilities.

The following degrees are offered in the basic sciences:

1. **Ph.D. in Marine Biology (Department of Biology).** The Department of Biology offers a Doctor of Philosophy degree with majors in marine biology and in zoology. Candidates for doctoral degrees must earn a minimum of 118 quarter hours of credit beyond the baccalaureate degree, or 72 quarter hours of credit beyond the master's degree. Forty-eight quarter hours must be spent on the Hattiesburg campus. A candidate is admitted to the doctoral program conditionally upon completion of a qualifying entrance examination which is administered during the first quarter on the main campus, and after successfully demonstrating a reading knowledge of two foreign languages. Candidates are admitted to candidacy for the degree only after successfully passing a comprehensive examination which is administered at or near completion of the course work, after completion of the language requirement and at least one year prior to graduation. A final oral examination is administered after the dissertation has been accepted.

2. **M.A., M.S. in Biology (Department of Biology).** Candidates for the Master of Arts or Master of Science degrees must earn 46 quarter hours of graduate credit. For the Master of Arts degree a candidate must take 16 hours of an approved academic minor, must demonstrate proficiency in a foreign language and write a thesis. For the Master of Science degree a candidate must elect a minor in an approved field and a major from biology, zoology, botany, microbiology, or marine biology, and write a thesis. The candidate must complete a Graduate Record Examination before acceptance as a graduate student. An English Proficiency Examination and a Comprehensive Examination are also required. The comprehensive examination is also a defense of thesis.

3. **M.A., M.S. in Geology (Department of Geology).** Candidates for the Master of Arts or Master of Science degrees must earn 46 quarter hours of graduate credit. For the Master of Arts degree a candidate must take 16 hours of an approved academic minor, demonstrate proficiency in a foreign language, and present an acceptable thesis. For the Master of Science degree, a candidate must elect a minor (16 hours) in an approved field and present an acceptable thesis. A departmental evaluation examination is required during the candidate's first quarter of residence, and he must present a combined Graduate Record examination score of 850 or higher for admission to degree candidacy; an English Proficiency Examination is also required, as well as a defense of thesis.

Marine science courses are offered by the Departments of Biology and Geology during the regular academic year. Summer courses in marine biology and geology are offered at the Gulf Coast Research Laboratory. Credits are in quarter hours.

Department of Biology

448	Comparative Animal Physiology	4
479	Introduction to Biological Oceanography	4
429	Marine Botany (GCRL)	4.5
431	Marine Vertebrate Zoology (GCRL)	9
454	Marine Invertebrate Zoology (GCRL)	9
515	Biological Oceanography	4
567	Marine Ecology	4
568	Planktology	4

Department of Biology—*Continued*

600	Advanced Problems in Marine Microbiology	6
604	Research in Marine Biology	Arranged
798	Dissertation	

Department of Geology

452	Physical Marine Geology (GCRL)	9
453	Chemical Marine Geology (GCRL)	9
454	Problems in Marine Sedimentation (GCRL)	9
479	Introduction to Geological Oceanography	4
485	Problems in Geology	4

The instructional staff for the courses listed above consists of the following:

Department of Biology

Stocks, Peter K., Ph.D., Acting Chairman and Associate Professor of Biology
Cliburn, Joseph W., Ph.D., Professor of Biology
Harrises, Antonio E., Ph.D., Professor of Biology
Walker, James F., Ph.D., Professor of Biology
Fish, Arthur G., Ph.D., Assistant Professor of Biology
Fischer, Barbara A., Ph.D., Assistant Professor of Biology
Pessoney, George F., Ph.D., Assistant Professor of Biology

Department of Geology

Bowen, Richard L., Ph.D., Chairman and Professor of Geology
Paulson, Oscar L., Ph.D., Associate Professor of Geology

To obtain further information, address all inquiries directly to:

Department of Biology
Dr. Peter K. Stocks
Acting Chairman, Department of Biology
University of Southern Mississippi
Hattiesburg, Mississippi 39401

Department of Geology
Dr. R. L. Bowen
Chairman, Department of Geology
University of Southern Mississippi
Hattiesburg, Mississippi 39401

HOPKINS MARINE STATION OF STANFORD UNIVERSITY
Pacific Grove, California

The Station occupies an exposed rocky headland, Mussel Point. The University holds title to about 11 acres on and around the point, which includes approximately one mile of shoreline. The intertidal and offshore waters surrounding the Marine Station, rich in marine life, are protected by law as a marine reserve, and provide excellent resources for research and teaching in marine biology. The Station operates as a branch of the Department of Biological Sciences of the University. The teaching and research facilities at the Station are housed in three main buildings. The Agassiz Laboratory provides space and equipment for studies in the biology and ecology of marine invertebrates, fishes and algae. A three-story concrete structure, it contains three large teaching laboratories and office and research space for staff, graduate students, and visiting investigators. Special facilities include rooms equipped for microtechnique and photomicrography, a large aquarium room, a reference collection of marine invertebrates, and the Gilbert M. Smith herbarium of marine algae. The two-story Jacques Loeb Laboratory provides rooms and other facilities for experimental studies on the development, physiology, and biochemistry of marine animals, plants, and microorganisms. Cold rooms, constant temperature rooms, and a photographic darkroom are available. The laboratories are equipped with a wide variety of specialized equipment including a gas chromatograph, recording spectrophotometers, radiation counting equipment, high speed refrigerated centrifuges, a preparative ultracentrifuge, neurophysiological equipment, and facilities for electrophoresis and chromatography. The Marinostat houses two large laboratories, 10 smaller research rooms, and six dark laboratories now being equipped for experimental temperature and light regimes. In addition to seawater at normal ocean temperatures, all laboratories are supplied with refrigerated seawater for maintaining lower temperatures. The library is housed on the upper floor of the Jacques Loeb Laboratory. It contains a constantly expanding collection of books in the fields most under study (algology, invertebrate zoology, development, ecology, physiology. biochemistry, microbiology, and biological oceanography). The collection currently consists of some 12,000 volumes. About 450 serial publications in these fields are received.

The research vessel PROTEUS, a 96-foot motor vessel with a 6000 mile range, provides the base for graduate training in biological oceanography. The ship carries a scientific party of 9 and is outfitted as a floating laboratory for observation, collection, experimentation, and teaching. Deepsea trawling and hydrographic winches permit sampling at depths of up to 6000 meters. The ship is equipped with a variety of gear for physical measurement, chemical analysis, and the collection, examination, and maintenance of living organisms. In addition a small reference library is carried which is changed to suit the needs of each cruise. Several skiffs and a launch and diving equipment are carried for inshore work.

Two smaller research vessels, the TAGE, a 40.5-foot launch, and a 26-foot whaler are equipped with winches and oceanographic equipment for more limited studies in Monterey Bay. Several small skiffs are available for inshore work.

The Station offers the degree of **Doctor of Philosophy in Biology**, with specialization in algology, invertebrate zoology, development, ecology, physiology, biochemistry, or biological oceanography.

In addition the Station provides: (a) courses in marine biology and biological oceanography designed for matriculated and non-matriculated undergraduates and graduate and professional biologists during the summer quarter; (b) a program of training in research for matriculated and non-matriculated undergraduates and graduates in biology during the spring (Biology 175H) and summer quarters (Biology 176H and 199H)–students after completion of Biology 175H may continue their research during the summer by enrolling in Biology 176H or 199H; (c) a program of graduate study and research in marine biology and biological oceanography leading to the degrees of Master of Arts and Doctor of Philosophy during all four quarters.

The following courses are offered in conjunction with the above programs:

100H	Marine Algae
101H	Physiology of Algae
111H	Marine Invertebrates

112H	Marine Invertebrates (continued)
117H	Zooplankton
119H	Marine Ecology
120H	Marine Ecology (continued)
147H	Comparative and Experimental Embryology
148H	Comparative and Experimental Embryology (continued)
176H	Problems in Biological Oceanography
199H	Special Problems
222H	Biological Oceanography
261H	Comparative Biochemistry of Marine Organisms
269H	Ecological Physiology
300H	Research

The instructional staff for the courses listed above consists of the following:

Abbott, Donald Putnam, Ph.D., Professor of Biology and Associate Director, Hopkins Marine Station
Abbott, Isabella Aiona, Ph.D., Research Biologist
Blinks, Lawrence Rogers, Ph.D., Acting Professor of Biology, Emeritus
Epel, David, Ph.D., Assistant Professor of Biology
Giese, Arthur Charles, Ph.D., Professor of Biology
Gilmartin, Malvern, Ph.D., Professor of Biology
Lee, Welton Lincoln, Ph.D., Professor of Biology, Director, Hopkins Marine Station
Wheeler, Ellsworth Haines, Ph.D., Acting Assistant Professor of Biology
Womersley, H. B. S., Ph.D., Acting Associate Professor of Biology

To obtain further information, address all inquiries directly to:

John H. Phillips, Director
Hopkins Marine Station
Pacific Grove, California 93950

TEXAS A&M UNIVERSITY
College Station, Texas

The University's Department of Oceanography is housed in two buildings on the main campus in College Station. The facilities available to students include the Texas A&M Marine Laboratory at Galveston and the fully-equipped 180-foot research vessel R/V ALAMINOS.

The University offers the degrees of **Ph.D. in Oceanography** and **M.S. in Oceanography** through its Department of Oceanography.

A student in the Ph.D. program will, after admission to graduate study, consult the head of his major of administrative department concerning appointment of his advisory committee. This committee will consist of not less than five members of the Graduate Faculty representative of the student's several fields of study and research; two of the members must be from disciplines outside the major field.

The committee will evaluate the student's previous training and degree objectives. They will then outline a degree program and research problem which, with the dissertation, will constitute the basic requirements for the degree. The degree program will be submitted on standard forms for the approval of the Dean of the Graduate College, who will, at the time of approval, appoint a representative of the Graduate Council to the student's committee. The field of study may be chiefly in one department or may be in a combination of departments. The chairman of the committee will normally have immediate supervision of the student's research and dissertation. The degree program should be submitted before the second registration after a student enters into graduate study.

To qualify for the preliminary examination, the student must have satisfied the language requirements and have completed all but approximately six hours of the formal course work on the Degree Program, excluding 691 (Dissertation Research). The examination shall be both oral and written unless otherwise recommended by the student's committee and the Graduate Council Representative and approved by the Dean of the Graduate College. The written part of the examination will cover each field of study included in the student's program and both parts of the examination must be completed within a length of time approved by the Dean of the Graduate College, usually not exceeding two weeks. Credit for the preliminary examination is not transferable.

The general field of research to be used for the dissertation should be agreed on by the student and his committee at their first meeting, as a basis for selecting the proper courses to support the proposed research.

In the M.S. program, the student's committee, in consultation with the student, will develop his Degree Program. This should be completed and filed with the Dean of the Graduate College, whose approval is required, prior to the second registration.

This Degree Program must be submitted on the official form with endorsements by the student's advisory committee. Any prerequisite courses recommended should also be listed on the form.

The student must prepare a thesis proposal for approval by his committee. This proposal must be submitted for the approval of the Dean of the Graduate College at least 14 weeks prior to the close of the semester or summer session in which the student expects to receive his degree.

A minimum of two full semesters of approved courses and research (32 semester hours) is required for the Master of Science degree.

Ordinarily the student will devote the major portion of this time to work in one field or two closely related fields. Other work will be in supporting fields of interest. In general, not less than one third of the course work, exclusive of research, should be taken in one or more fields outside the major field.

Specialization may be undertaken for both the M.S. and Ph.D. degrees in biological, chemical, geological, meteorological, and physical oceanography. It is also possible for certain students with undergraduate degrees in engineering to substitute engineering course work for up to 15 semester hours of prerequisites for the discipline in which advanced work is desired. Such a program usually consists of the regular physical oceanography program with a minor in engineering. Students may also enroll in pertinent courses offered in other departments, e.g.: Geology and Geophysics, Biology, Mathematics, and Physics among others. An effort is made to maintain a balance between the biological, chemical, geological and physical aspects of oceanography both in teaching and research.

The following courses are offered in conjunction with the above programs:

205	Survey of Oceanography	1
401	Introduction of Oceanography	3
603	Sea Laboratory Techniques	1
608	Physical Oceanography	4
609	Physical Oceanography	3
611	Theoretical Physical Oceanography	3
612	Elements of Ocean Wave Theory	3
613	Engineering Aspects of Oceanography	3
614	Dynamics of the Ocean and Atmosphere	3
615	Long Waves and Tides	4
616	Theory of Ocean Waves	3
617	Theories of Ocean Circulation	3
620	Biological Oceanography	3
622	Analysis of Benthic Communities	3
623	Marine Zooplankton	3
624	Marine Phytoplankton	3
630	Geological Oceanography	3
631	Geological Oceanography	3
632	Lithophycology Oceanography	3
633–34	Carbonate Sediments	2
635	Techniques in Geological Oceanography	4
638	Simulation Techniques	4
640	Chemical Oceanography	3
641	Chemical Oceanography	3
642	Laboratory Techniques in Oceanography	2
643	Geochemistry of the Ocean	3
644	Isotope Geochemistry	3
651	Meteorological Oceanography	3
652	Ocean Boundary Layer Problems	3
653	Synoptic Physical Oceanography	3
681	Seminar I	1
682	Seminar II	1
685	Problems	1
691	Research (1 or more each semester)	1–4

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Oceanography

Geyer, Richard A., Ph.D., Professor and Head of the Department of Oceanography
Berner, Leo, Jr., Ph.D., Associate Professor of Biological Oceanography
Bouma, Arnold H., Ph.D., Associate Professor of Geological Oceanography
Bryant, William R., Ph.D., Associate Professor of Geological Oceanography
Capurro, Luis R. A., D.Sc., Lecturer Physical Oceanography
Caruthers, Jerald W., Ph.D., Assistant Professor of Physical Oceanography
Clayton, William H., Ph.D., Professor of Physical Oceanography
Cochrane, John D., M.S., Associate Professor of Physical Oceanography
Darnell, Rezneat M., Ph.D., Professor of Biological Oceanography
El-Sayed, Sayed Z., Ph.D., Associate Professor of Biological Oceanography
Ichiye, Takashi, D.Sc., Professor of Physical Oceanography
Jeffrey, Lela M., M.S., Lecturer Chemical Oceanography
Krishnamurty, Kotra V., Ph.D., Associate Professor of Chemical Oceanography
Nowlin, Worth D., Jr., Ph.D., Associate Professor of Physical Oceanography

Department of Oceanography–*Continued*

Pequegnat, Willis E., Ph.D., Professor of Biological Oceanography

Ray, Sammy M., Ph.D., Associate Professor of Biological Oceanography and Director of the A&M Marine Laboratory

Reid, Robert O., M.S., Professor of Physical Oceanography

Rezak, Richard, Ph.D., Associate Professor of Geological Oceanography

Sackett, William M., Ph.D., Associate Professor of Chemical Oceanography

To obtain further information, address all inquiries directly to:

Dr. Richard A. Geyer
Head, Department of Oceanography
Texas A&M University
College Station, Texas 77843

TEXAS CHRISTIAN UNIVERSITY
Fort Worth, Texas

Most of marine science is carried out under the environmental sciences group of the TCU research foundation. Facilities include a 26-foot cruiser, equipped with depth recorder, winch, boom and a portable six-sensor water quality system with 24 channel multipoint recorder. Individual sensing equipment owned by the group consists of salinometer, oxygen meter, current strength and direction sensors and readout, pH meters, specific ion electrodes. Sampling equipment consists of a gravity corer, several bottom grabs, otter trawls, epibenthic trawl, dredges, plankton nets, scuba diving and underwater photographic equipment. Analytical equipment consists of atomic absorption spectrophotometer, X-ray fluorescence and diffraction units, gas chromatographs, various spectrophotometers, model E analytical ultracentrifuge, and an Hitashi H-8 electron microscope. Three laboratory areas have been set aside for marine-oriented research.

No specific degree in marine science is offered. **M.S. degrees in Biology and Geology with emphasis on marine problems** are offered.

The following courses are offered by the departments indicated in conjunction with the above programs:

Department of Biology

3104	Invertebrate Zoology (once a year)	4
5713	Marine Ecology (alternate years)	3
6103	Invertebrate Morphology and Physiology (alternate years)	3
6323	Principles of Paleoecology* (alternate years)	3
6503	Fishery Biology (alternate years)	3
7000	Special Topics in Marine Sciences (upon demand)	3
7900	Thesis Research	6

Department of Geology

3123	Descriptive Oceanography	Sp	3
5243	Geochemistry of Natural Waters	Alt. F	3
5313	Micropaleontology	Alt. Sp	3
5513	Sedimentation	Alt. F	3

The instructional staff for the courses listed above consists of the following:

Department of Biology

Smith, J. Durward, Ph.D., Chairman and Assistant Professor of Biology
Blanton, William George, Ph.D., Adjunct Professor (from Texas Wesleyan College)
Couch, Ernest, Ph.D., Assistant Professor of Biology
Hewatt, Willis G., Ph.D., Professor of Biology
Keith, Donald E., Ph.D., Assistant Professor of Biology
Lyles, Sanders T., Ph.D., Professor of Biology
Newland, Leo G., Ph.D., Post-doctoral Fellow in sediment and water chemistry
Parker, Robert H., Doctoranden, dr. phil., Director, Environmental Sciences Group, Associate Professor of Biology

Department of Geology

Ehlmann, Arthur J., Ph.D., Chairman and Associate Professor of Geology
Heuer, Edward, M.S., Associate Professor of Geology
Slowey, J. Frank, Ph.D., Research Scientist, TCU Research Foundation, Assistant Professor of Geology
Steinmetz, Richard, Ph.D., Assistant Professor of Geology

To obtain further information, address all inquiries directly to:

Dean, Graduate School
Texas Christian University
Fort Worth, Texas 76129

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*This course is also offered under the same number by the Department of Geology.

THE UNIVERSITY OF TEXAS MARINE SCIENCE INSTITUTE
Port Aransas, Texas

The University offers courses in the marine sciences at both its main campus at Austin and its Marine Science Institute at Port Aransas, Texas. Research facilities on the 61-acre site of the Institute at Port Aransas include: 20,000 square feet of research, biological collection, library, and shop space. Most of this is air-conditioned. A laboratory with running seawater is located on a pier over the Aransas Pass inlet. There is a special air-conditioned vibration-free laboratory. Twenty concrete and fiberglass experimental ponds are located on the grounds. A variety of small boats, an air-boat and a 40-foot self-propelled barge are available, as well as the 44-foot LORENE, a trawler used in securing specimens. The Institute's boat basin is located adjacent to the laboratory buildings at the Aransas Pass ship channel.

Master of Arts and Doctor of Philosophy degree programs **in the biological, physical, or earth sciences** may be concentrated in the area of marine science. Marine science courses listed in the offerings of the various Main University science departments may be used as supporting work for programs in these or other science departments where they are pertinent.

1. **M.A. in botany, chemistry, geology, microbiology, physics, zoology, or engineering** with work concentrated in marine science.

Nine to 12 hours of marine science as the minor may be combined with 12 to 15 hours of the major and 6 hours of thesis registration for a total of 30 hours. There is no language requirement for the Masters degree in most of the related departments except Geology. The program of study and the thesis are approved by a supervisory committee appointed by the dean.

2. **Ph.D. in botany, chemistry, geology, microbiology, physics, zoology, or engineering** with work concentrated in marine science.

General Marine Science, Mn.S. 680, and the Principles of Marine Science, Mn.S. 382, are recommended as given in summers at Port Aransas along with courses in the major and supporting areas in Austin as designated by the supervising committee. Requirements and examinations for admission to candidacy vary according to the specifications of the Graduate Faculty of the Major Department in Austin as indicated in the Graduate Catalogue of the Main University. German, French or Russian is generally used to fulfill the language requirement of the Graduate School. A second language is part of the degree requirements of the major in most of the related science departments. There is no set number of course hours required. The program of study, languages, final oral exam and doctoral dissertation are approved by the supervisory committee and the Dean.

Courses in the marine sciences are offered during the regular long sessions at the Austin campus by the departments of Zoology, Geography, Civil Engineering, Meteorology, and Geology. The Marine Science Institute also offers regular summer courses and thesis research or special problems courses all year long at Port Aransas.

Courses Offered at Port Aransas

382.1	Marine Invertebrates	3
382.2*	Marine Microbiology	3
382.3*	Marine Geology	3
382.4	Marine Botany	3
382.52	Marine Ichthyology	3
382.53*	Ecology of Fishes	3
382.6	Marine Chemistry	3
382.7*	Adaptive Mechanics in Marine Animals	3
382.8*	Estuarine Ecology	3
341†	General Marine Science	3
481	Biological Oceanography and Marine Ecology	3
680	Research in Marine Science	6

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*Offered Summer 1969 as 342. series for advanced undergraduates.

†Undergraduate course.

Courses Offered at Port Aransas—*Continued*

680.1	Biological Oceanography, Marine Ecology, Limnology	6
680.2	Marine Microbiology	6
680.3	Marine Geology	6
680.4	Marine Botany	6
680.5	Marine Ichthyology	6
682.6	Marine Chemistry	6
687	Adaptive Mechanisms in Marine Animals	6
688	Estuarine Ecology	6
690	General Marine Science	6
698	Thesis	6
699	Dissertation	6

Courses Offered at Austin Campus

(Excluding courses such as special problems, conference, dissertation, thesis, and seminar courses that may deal with marine sciences)

241	Environmental Health Engineering (Dept. of Civil Engineering)
342	Water Supply and Waste Water Disposal (Dept. of Civil Engineering)
364	Oceanography (Dept. of Geography)
376	Physical Oceanography (Dept. of Meteorology)
391.2	Marine Geology—Fall 1968 (To be given separate course number 1969-70)
391.2	Oceanography & Limnology—Spring 1968 (To be given separate course number)
391.2	Sedimentary Geochemistry—Spring 1968 (To be given separate course number)
400	Limnology and Oceanography (Dept. of Zoology)

The University also offers a graduate program in ocean engineering which is described in the Ocean Engineering section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Botany

Van Baalen, C., Ph.D., Associate Professor of Botany

Department of Chemistry

Parker, P. L., Ph.D., Assistant Professor of Chemistry

Department of Geology

Behrens, E. W., Ph.D., Assistant Professor of Geology

Department of Zoology

Wohlschlag, Donald E., Ph.D., Institute Director and Professor of Zoology
Copeland, B. J., Ph.D., Associate Professor of Zoology
Nicol, J. A. C., D.Sc., Professor of Zoology

To obtain further information, address all inquiries directly to:

Dr. Donald E. Wohlschlag, Director
The University of Texas
Marine Science Institute
Port Aransas, Texas 78373

UNITED STATES COAST GUARD ACADEMY
New London, Connecticut

The Academy facilities include extensive physics and chemistry laboratories including a laboratory specially constructed for the study of biological and chemical oceanography. Hydrodynamics and structural mechanics instructional facilities include a 30-foot wave tank and generator. An array of small craft are maintained at the Academy and used by the Ocean Science Section for local field work during the academic year. Completely equipped sea going multipurpose oceanographic vessels, in excess of 300 feet long, are utilized during the summer semester. These vessels are used for training cadets in oceanographic sampling programs mainly in the Atlantic and Caribbean during a portion of the summer semester. An IBM 1620 Computer, located at the Academy, is used in most of the Ocean Science courses and research projects being carried out.

The **Bachelor of Science (non-specified)** is offered by the Academy. At the end of the sophomore year, after two years of pre-engineering subjects, cadets have the option of selecting a curriculum to follow in one of three major study areas: Social Science, Engineering Science, and Ocean Science. The Ocean Science curriculum is divided into two sub-major areas: Oceanography and Ocean Engineering. All Ocean Science cadets must take the following courses: 5321, 5323, 5326, and 5420. Those Ocean Science cadets electing to sub-major in Ocean Engineering must, in addition to following the Engineering Science curriculum, take 1490. Those Ocean Science cadets electing to sub-major in Oceanography must, in addition to the required Thermodynamics and Fluid Mechanics courses, take an additional three specified ocean science courses.

The following courses in Ocean Science are offered by the Physical Science Department, Ocean Science Section and the Applied Science and Engineering Department during the academic year. All summer at-sea programs, as well as all ocean research, are sponsored by the Physical Science Department.

5301	Oceanography/Meteorology	3.5
5321	Physical Oceanography	4
5323	Biological/Chemical Oceanography	4
5326	Meteorology	4
5420	Waves and Tides	3.5
5422	Regional Oceanography	4
5423	Harbor Circulation and Pollution	4
5424	Air Sea Interaction	4
5425	Marine Biology/Geology	4
5426	Chemical Oceanography	4
5427	Marine Fisheries	3
5428	Observation Survey Techniques	3
1490	Ocean Engineering Design and Analysis	3.5

The instructional staff for the courses listed above consists of the following:

Ocean Science Section, Department of Physical Science

Kollmeyer, Ronald C., CDR, USCG, M.S., Section Head and Associate Professor of Oceanography
McGill, David A., Ph.D., Professor of Oceanography
Nagel, Harold A., M.S., Assistant Professor of Oceanography/Meteorology
Costello, Hugh, MALS, Assistant Professor of Chemistry/Oceanography
Lissauer, Ivan A., B.S., Instructor of Oceanography/Meteorology

Ocean Engineering Section, Department of Applied Science and Engineering

White, Roderick M., Nav.E. Sc.D., Section Head and Associate Professor Marine Engineering

To obtain further information, address all inquiries directly to:

Dean of Academics
U. S. Coast Guard Academy
New London, Connecticut 06320

GRADUATE SCHOOL
U.S. DEPARTMENT OF AGRICULTURE
Washington, D. C.

A Certified Statement of Accomplishment in Oceanography is granted to a student who has completed an organized program of courses in the field. The requirements for this Certified Statement are 20 semester hours of credit with a grade of C or better in each of the following courses:

a. Required courses (6 credits):
  - Biological Oceanography (2)
  - Geological Oceanography (2)
  - Physical Properties of Sea Water (2)

b. Electives (8 credits to be selected from the following group):
  - Applied Underwater Sound (2)
  - Biological Oceanography (4)
  - Chemical Oceanography (2)
  - Dynamic Oceanography (2)
  - Marine Geophysics (2)
  - Marine Meteorology (2)
  - Ocean Surface Waves (2)
  - Physics of Marine Atmosphere (2)
  - Practical Electronics for Biologists and Chemists (4)
  - Principles of Underwater Sound (2)

c. 6 semester hours of credit in fields related to oceanography, including biology, chemistry, engineering, geography, geology, mathematics, and meteorology.

A student seeking this certified statement should consult with the Registrar and obtain approval of his proposed course of study early in his academic program. Equivalent courses will be accepted by transfer from other institutions. An applicant for this certified statement must file a transcript of his high school or college record before completion of his program.

The following courses are offered in conjunction with the school program:

5-360	General Oceanography	F, Su	2
5-414	Celestial Navigation	F, Sp	3
5-475	Principles of Underwater Sound	F	2
5-476	Applied Underwater Sound	Sp	2
5-584	Physical Properties of Sea Water	Sp	2
5-655	Ocean Surface Waves	Sp	2
5-658	Geological Oceanography	F	3
5-546	Physics of Marine Atmosphere	Sp	2
5-520	Marine Geophysics	F	2
5-662	Marine Meteorology	Alt. F	2
5-664	Dynamic Oceanography	F	2
5-666	Biological Oceanography	F, Sp	2

The instructional staff for the courses listed above consists of the following:

Ackerman, Karl H., Navigational Scientist, U.S. Naval Oceanographic Office
Anderson, Rockne S., Oceanographer, U.S. Naval Oceanographic Office
Burkhart, M. D., M.S., Oceanographer, U.S. Naval Oceanographic Office
Cuzon Du Rest, Rene P., M.S., Oceanographer, National Oceanographic Data Center
Gilcrest, Robert A., Physical Oceanographer, U.S. Naval Oceanographic Office
Paulus, William C., Oceanographer-Instructor, U.S. Naval Oceanographic Office
Peloquin, Robert A., Physical Oceanographer, U.S. Naval Oceanographic Office
Picciolo, Anthony R., Ph.D., Head, Hydrobiology Branch, National Oceanographic Data Center
Schule, J. J., Jr., B.A., Director, Oceanographic Prediction Division, U.S. Naval Oceanographic Office

Weiss Martin, Ph.D., Head, Geoscience Branch, National Oceanographic Data Center

Winokur, Robert S., B.S., Oceanographer, Acoustical Oceanography Branch, U.S. Naval Oceanographic Office

To obtain further information, address all inquiries directly to:

The Registrar
Graduate School
U.S. Department of Agriculture
Washington, D. C. 20250

UNITED STATES NAVAL ACADEMY
Annapolis, Maryland

Facilities available include a recently completed environmental science laboratory with a semiautomatic weather station and an environmental data center. The laboratory is well equipped to support student research projects. A research vessel is available for use in the Oceanographic Applications course and for individual or group research. The 65-ton, 84-foot vessel has diesel-powered twin screws and is completely instrumented for data-collection and bathymetric surveying.

The Academy offers the **B.S. degree** with a **major or minor specified in Oceanography.** A core of required courses provides the student with a broad liberal education in mathematics, science, social science, and a thorough background in engineering, seamanship, navigation, and weaponry.

The following marine science courses are offered by the departments indicated:

Naval Science Department

N-105	Air-Ocean Environment	3
N-603	Oceanography	3
N-607	Meteorology	3
N-705	Ocean Waves, Tides and Ice	3
N-708	Synoptic Meteorology	3
N-821	Nearshore Oceanography	3
N-832	Oceanographic Applications	4
N-902	Environmental Science Research Project	3

Science Department

S-609	General Biology I	3
S-610	General Biology II	3
S-611	General Geology I	3
S-612	General Geology II	3
S-720	Chemical Oceanography	3
S-727	Biological Oceanography	3

The instructional staff for the courses listed above consists of the following:

Naval Science Department

Oceanography Committee

MacPherson, John J., Commander, USN, M.S., Committee Chairman
Hoffman, John, Ph.D., Associate Professor
Williams, Jerome, M.A., Associate Professor
Traganza, Eugene D., Ph.D., Associate Professor
Hendrix, Charles N. G., M.S., Associate Professor
Brookes, Allen G., LCDR, USN, M.S., Instructor
Schramm, William G., LCDR, USN, M.S., Instructor
Kelley, Robert D., LCDR, USN, M.S., Instructor
Tupaz, Jesus B., LT, USN, M.S., Instructor
Sharp, John B., LT, USN, B.S., Instructor
Smith, John A., LT, USN, M.S., Instructor

To obtain further information, address all inquiries directly to:

Dean of Admissions
U. S. Naval Academy
Annapolis, Maryland 21402

VIRGINIA INSTITUTE OF MARINE SCIENCE
Gloucester Point, Virginia

The Institute is located on the York River 30 miles from the mouth of Chesapeake Bay. A second campus at Wachapreague on seaside of Virginia's Eastern Shore provides access to the barrier beaches, lagoons, and marshes of the Atlantic Coast. Facilities include modern, permanent laboratory buildings, a research fleet with regular cruises over the continental shelf and a year-round research program.

All classwork and graduate study is directed by working scientists in the environment of an active marine research program. Modern laboratory and field instruments are available. An electron microscope has recently been added to the laboratory equipment inventory.

Research is being carried on in marine ecology, physiology of marine organisms, pollution problems, microbiology, radiobiology, diseases of shellfish, fish life histories, fishery biology, chemical oceanography, marine geology, meteorology, physical oceanography and parasitology.

The Institute offers the degrees of **Master of Arts** and **Doctor of Philosophy in Marine Science** through the School of Marine Science, College of William and Mary, Williamsburg, Virginia, and the degrees of **Master of Arts** and **Doctor of Philosophy in Marine Science** through the Department of Marine Science, University of Virginia, Charlottesville, Virginia, all with majors in Biological Oceanography, General Oceanography and Fishery Biology.

The following courses are offered in conjunction with the above program. These courses are also offered under different numbers by the Department of Marine Science, University of Virginia.

401	Introduction to Physical Oceanography	3
402	Introduction to Chemical Oceanography	3
403	Introduction to Biological Oceanography	3
404	Introduction to Geological Oceanography	3
405	Problems in Marine Science	Maximum of 4
406	Introduction to Marine Science	5
407	Biometry I	4
410	Marine and Freshwater Invertebrates	5
412	Marine Botany	5
415	Marine Botany—The Fungi	5
501	Marine Science Seminar	Maximum of 4
502	Biological Oceanography	5
503	Advanced Problems in Marine Science	Maximum of 4
504	Biology of Selected Marine Organisms	5
505	Radiobiology	5
506	Biology of Plankton	5
507	Marine Microbiology	5
508	Ichthyology	5
509	Physical Oceanography	5
510	Pollution Biology	5
511	Geological Oceanography	3
512	Parasites of Marine Organisms	5
513	Marine Biogeography	3
514	Littoral Processes	4
515	Embryology of Marine Invertebrates	5
516	Advanced Physical Oceanography	3
517	Behavior of Marine Organisms	5
518	Marine Fishery Science	5
519	Biometry II	4
520	Comparative Animal Physiology	3
521	Chemical Oceanography	4

522	Comparative Animal Physiology Laboratory	2
523	Topics in Applied Marine Science	Maximum of 4
560	Thesis	

The instructional staff for the courses listed above consists of the following:

Hargis, William Jennings Jr., Ph.D., Dean and Professor
Andrews, Jay Donald, Ph.D., Professor
Black, Robert E. Lee, Ph.D., Professor
Brehmer, Morris Leroy, Ph.D., Professor
Joseph, Edwin Bibb, Ph.D., Professor
Van Engel, Willard Abraham, Ph.M., Professor
Wood, John Langille, Ph.D., Professor
Davis, William Jackson, Ph.D., Associate Professor
Haven, Dexter Stearns, M.S., Associate Professor
Nichols, Maynard M., Ph.D., Associate Professor
Norcross, John Judson, M.S., Associate Professor
Wass, Marvin Leroy, Ph.D., Associate Professor
Wood, Langley Harris, Associate Professor
Bailey, Robert Sydnor, M.S., Assistant Professor
DuPuy, John L., Ph.D., Assistant
Grant, George C., Ph.D., Assistant Professor
MacIntyre, William Gordon, Ph.D., Assistant Professor
Perkins, Frank Overton, Ph.D., Assistant Professor
Ruzecki, Evon Paul, M.S., Assistant Professor
Wang, Humphrey Yee-Chang, Ph.D., Assistant Professor
Webb, Kenneth Louis, Ph.D., Assistant Professor
Hyer, Paul V., B.S., Instructor
Musick, John A., Ph.D., Instructor
Owens, Dean Paul, M.S., Instructor
Warinner, Junius Ernest III, M. A., Instructor
Wojcik, Frank John, M.S. Instructor
Zwerner, David Eric, M.A., Instructor

To obtain further information, address all inquiries directly to:

Dr. William J. Hargis, Jr.
Director
Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

WALLA WALLA COLLEGE
College Place, Washington

The college offers courses in marine biology at its marine station on Puget Sound. Facilities for the maintenance and use of marine organisms in research are also located in the new Life Sciences Complex on the main campus. Facilities at the Walla Walla College Marine Biological Station include four laboratory buildings which provide the following research laboratories: a general laboratory, a photoperiod laboratory for studies which must run under controlled environment conditions, a physiology research laboratory, three teaching laboratories, and a small general purpose laboratory. These are serviced by a circulating water system. In addition, the Marine Station operates a 40-foot research vessel and a smaller 26-foot cruiser which is available for research use. Also, a number of smaller boats are available.

The M.S. in biological sciences is offered by the college. All students must complete 45 graduate credits, pass departmental examinations, and carry out original research leading to a thesis.

Courses are offered by the Biology Department during the summer session at the Marine Station.

427	Coastal Flora
429	Limnology
461	Invertebrate Zoology
462	Ichthyology
463	Marine Botany
467	Biological Oceanography
468	Comparative Physiology
524	Marine Invertebrates

The instructional staff for the courses listed above consists of the following:

Blake, Donald F., Ph.D., Acting Director
Forss, Carl A., Ph.D., Assistant Professor of Biology
Grable, Albert E., Ph.D., Assistant Professor of Biology
Rigby, Donald W., Ph.D., Professor of Biology and Head of Biology Department

To obtain further information, address all inquiries directly to:

Donald F. Blake
Acting Director
Marine Biological Station
Walla Walla College
College Place, Washington 99324

UNIVERSITY OF WASHINGTON
Seattle, Washington

DEPARTMENT OF OCEANOGRAPHY. The Department of Oceanography is located on the University campus on the shore of the Lake Washington Ship Canal. A new research building, and a new teaching building, have added to the facilities of the original building. Special facilities of the Department include a Development Laboratory with electronic mechanic shops, constant temperature rooms, a closed salt-water system, tidal models of Puget Sound and parts thereof, wave tanks and rotating models, and isotope ratio spectrophotometer, X-ray emission and gamma-ray spectrophotometers, a shipboard computer and a SCUBA support facility. Staging and dock facilities for research and training vessels of ocean-going size have recently been completed.

The Department has three research vessels, from 65 to 208 feet long, capable of cruising to any area of the world, which are berthed adjacent to the new research building. The use of various charter vessels is also available.

FRIDAY HARBOR LABORATORIES. The Friday Harbor Laboratories are located on a 484-acre tract on San Juan Island in the San Juan Archipelago of Washington State. Professors from various departments of the University (Botany, Fisheries, Atmospheric Sciences, Microbiology, Oceanography and Zoology) offer courses at a primarily graduate level with facilities also provided for independent researchers.

Representatives of all major and most minor phyla of invertebrates can be collected within a reasonable distance from the Laboratories. Shore collecting and dredging in many diverse ecological situations provide an abundance of forms for ecological, experimental, morphological and systematic work. A 55-foot power boat and fiberglass rowboats are available for sampling work. A cantilever pier is equipped for making various types of observations and is the location for the intakes of sea water systems for the laboratories. The teaching and research laboratories are housed in six one-story buildings and a new larger two-story building. Biological laboratories, photographic darkrooms, walk-in cold rooms, microtechnique rooms and a shop are available. A 9,000 volume library is maintained on the Friday Harbor Campus by the University of Washington Library system. Housing and dining facilities are available for both single and family residences.

The following degrees are offered in the Department of Oceanography:

1. **Bachelor of Arts.** The student in the Bachelor of Arts curriculum must meet the requirements of the College of Arts and Sciences which include two years of language study (French, German or Russian recommended) and work in the fields of Humanities, Social Sciences and Natural Sciences. In addition, he must complete work in chemistry, geology, mathematics, physics and zoology. Required courses in Oceanography are Oceanography 203, 405 or 450, 401, 402 or 404J, 410, 412, 421-422, 423, 433 and 435 or 434 and 435.

2. **Bachelor of Science.** The Bachelor of Science curriculum is recommended for students contemplating graduate studies. The program requires approximately 35 credits in oceanography and the basic sciences beyond the curriculum for the Bachelor of Arts. French, German or Russian are the recommended languages. Before the end of the first two years the student should select one of four options. In addition to Oceanography 110-111-112, 443, 460 and 499 the options are in the fields of biological, chemical, geological and physical oceanography with course requirements determined by the area of interest.

3. **Master of Science.** The Department offers a thesis and a nonthesis program leading to the Master of Science degree. In both, the student and his adviser prepare a program of study to be approved by the student's Supervisory Committee. Proficiency in one foreign language, usually Russian, German, French or Japanese, must be demonstrated and Graduate School requirements for residence and course credits fulfilled. A qualifying written examination is required.

4. **Doctor of Philosophy.** The student and his Supervisory Committee prepare a program of study and research. A reading knowledge of two scientific languages, usually Russian, German, French or Japanese is required. The student must pass a General Examination in oceanography and supporting fields. He then completes the research for his dissertion and prepares for his Final Examination.

The Division of Marine Resources acts as coordinator of the work being carried out in the marine-related sciences between the many Departments and Colleges of the University which are active in this field. These include Atmospheric Sciences, Botany, Chemical Engineering, Civil Engineering, Economics, Fisheries, Food Science, Forestry, Geography, Geophysics, International Business, Law, Mechanical Engineering, Oceanography, and Zoology.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

Atmospheric Sciences

403J	Introduction to Geophysics: The Atmosphere	W	5
431	Atmospheric Physics	F	5
462	Sea-Air Transfer Processes	Su	6
511J	Glaciology I: Formation of Snow and Ice Masses	W	3
512J	Glaciology II: Structural Glaciology	Sp	3
513J	Glaciology III: Dynamic Glaciology	F	3
522	Advanced Regional Climatology	W	
528	Applied Meteorology and Bioclimatology	Sp	3
543, 544	Planetary Fluid Dynamics	W	3, 3
546, 547, 548	Atmospheric Turbulence	F, W, Sp	3, 3, 3
551	Advanced Atmospheric Analysis	Sp	5, max 10
560	Theory of Meteorological Instrument	W	3

Botany

445	Marine Algology	Sp	6
446	Algology	Sp	5
447	Phytoplankton Morphology and Taxonomy	Alt. F	4
448	Marine Algal Ecology	Alt. W	4
465	Marine Mycology	Su	6
475	Problems in Algal Physiology	Su	6
524	Topics in Algology	W	2, max 10

Geophysics

415	Principles of Glaciology	F	4
572	Tectonophysics	F	3

Oceanography

101	Survey of Oceanography	F, W, Sp, Su	5
109H	Survey of Oceanography–Honors	Sp	5
110, 111, 112	Lectures in Oceanography	F, W, Sp	1, 1, 1
180H	Lower-Division Tutorial–Honors	Su	6
203	Introduction to Oceanography	Sp	5
280H	Introduction to Oceanography–Honors	Sp	5
360	Methods and Instruments in Oceanography	Sp	3
380H	Upper-Division Tutorial–Honors	Su	6
385	The Oceans I	Su	10
386	The Oceans II	Su	10
401, 402	General Physical Oceanography I, II	F, W	5, 5
403	General Biological Oceanography	W	5
404	Introduction to Geophysics: The Ocean	F	5
405	General Geological Oceanography	Sp	5
406	Introduction to Geological Oceanography		5
410	Physical Oceanography	W	3
411	Ocean Tides and Waves	Sp	3
412	Ocean Currents	Sp	3
415	Fundamentals of Underwater Acoustics	F	3
416	Application of Underwater Acoustics	W	2

Oceanography—*Continued*

421, 422	Chemical Oceanography	F, W	2, 2
423, 424	Chemical Oceanography Laboratory	F, W	2, 2
433	Biological Oceanography: Organisms and Processes	W	3
434	Biological Oceanography: Organisms and Environments	W	3
435	Biological Oceanography: Quantitative Aspects	Sp	3
443	Regional Oceanography	Sp	2
444	Design and Analysis of Oceanographic Experiments		3
450	Geological Oceanography	Sp	5
452	Physical Sedimentology		3
454	Biogenic Sediments I	F	3
455	Biogenic Sediments II	W	3
456	Acoustic and Seismic Techniques	W	2
457	Marine Sedimentation		3
460, 461	Field Experience in Oceanography	F, W, Sp, Su	1, 1–5
462	Applications of Oceanography	W	2, Max 6
480H	Undergraduate Research–Honors	F, W, Sp	6
485	Topics in Oceanography		2
488H	Field Experience–Honors	F, W, Sp	2–6
489H	Undergraduate Thesis–Honors	F, W, Sp	1–6
499	Undergraduate Research	F, W, Sp	1–3, Max 6
505	Current Problems in Geological Oceanography		1
511, 512, 513	Marine Hydrodynamics I, II, III	F, W, Sp	4, 4, 4
514	Seminar in Physical Oceanography		1, Max 9
515	Waves	F (Odd Years)	2
516	Ocean Circulation	W (Even Years)	2
517	Oceanography of Inshore Waters	Sp (Odd Years)	5
518	Seminar in Dynamical Oceanography	F, W, Sp	Max 9
519	Interaction of the Sea and Atmosphere	Sp	5
520	Seminar	F, W, Sp	1, Max 9
521	Seminar in Chemical Oceanography	F, W, Sp	Max 9
523	Advanced Problems in Chemical Oceanography	F, W, Sp	1–4, Max 18
530	Marine Primary Productivity	Sp	3
531	Seminar in Biological Oceanography	F, W, Sp	Max 9
532	Marine Microbiology	Sp	1–4
533	Zooplankton Ecology	Sp	6
534	Phytoplankton Ecology	Sp	6
535	Advanced Plankton Ecology	Sp	2
536	Benthos Ecology	Sp	3
537	Environmental Physiology of Marine Microalgae	F	3
538	Identification and Structure of Marine Benthic Communities		2
540	Seminar in Geometrics	W	1–3
544	Statistical Models in Oceanography	W	3
548	Topics in Physical Oceanography		1–4, Max 9

Oceanography—*Continued*			
550	Seminar in Geological Oceanography	F, W, Sp	Max 9
551	Marine Sediments	Sp	3
553	Research Techniques in Marine Geochemistry		2
554	Research Techniques in Marine Geology	F	3
555	Marine Geochemistry		3
556	Advanced Marine Geology	Sp	3
560	Fluid Mechanics of Erosion and Sediment Transport	W	3
571	Gravity and Geomagnetic Interpretation		3
573	Terrestrial Magnetism		3
581	Analysis of Sediments and Sedimentary Rocks		5
600	Research	F, W, Sp, Su	Varied
700	Thesis	F, W, Sp, Su	Varied
702	Degree Final	F, W, Sp	3
Zoology			
432	Marine Invertebrate Zoology	Su	8
472	Principles of Ecology	W	3
533	Advanced Invertebrate Zoology	Su	6
536	Comparative Invertebrate Embryology	Su	6
572	Topics in Ecology	W	2–3
574	Ecology of Marine Communities	F	3
578	Advanced Ecology	F	5
International Business			
420	International Trade	W	5
Law			
539	Ocean Resources Seminar	F, W	3
550	Admiralty	F	3
574	Natural Resources	F	3
587	Natural Resources Seminar	W, Sp	4
Geography			
370	Conservation of Natural Resources	F, Sp	5
444	Geography of Water Resources	W	3 or 5
477	Urban Geography	F	3 or 5
449	Geography of Ocean Transportation	Sp	3 or 5

The University also offers undergraduate and graduate programs in ocean engineering and fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Atmospheric Sciences:

Fleagle, R. G., Ph.D., Chairman and Professor of Theoretical and Dynamical Meteorology
Badgley, F. I., Ph.D., Professor of Turbulence, Meteorological Instruments
Buettner, K. J. K., Ph.D., Professor of Radiation, Bioclimatology
Businger, J. A., Ph.D., Professor of Physical Meteorology, Turbulence
Church, P. E., Ph. D., Professor Climatology.
Holton, J. R., Ph.D., Assistant Professor of Fluid Dynamics
Reed, R. J., Sc.D., Professor of Synoptic Meteorology, Numerical Prediction
Untersteiner, N., Ph.D., Professor of Artic Heat Budget, Glaciology

Department of Botany

Norris, Richard Earl, Ph.D., Associate Professor of Algology
Whisler, Howard Clinton, Ph.D., Associate Professor in Aquatic Fungi

Geophysics Group

Untersteiner, N. (see Atmospheric Sciences)
Lister, Cliver R. N. (see Oceanography)

Department of Oceanography

- Rattray, Maurice, Jr., Ph.D., Chairman and Professor of Physical Oceanography
- Aagaard, Knut, Ph.D., Research Assistant Professor of Physical Oceanography
- Anderson, George C., Ph.D., Research Associate Professor of Biological Oceanography and Limnology
- Banse, Karl, Ph.D., Professor of Biological Oceanography
- Barnes, Clifford A., Ph.D., Professor of Physical Oceanography
- Bennett, Lee C., Ph.D., Assistant Professor of Geological Oceanography and Geophysics
- Broenkow, William W., M.S., Acting Assistant Professor of Chemical Oceanography
- Carpenter, Roy, Ph.D., Assistant Professor of Geochemical Oceanography
- Coachman, Lawrence K., Ph.D., Associate Professor of Physical Oceanography
- Creager, Joe S., Ph.D., Professor of Geological Oceanography
- Dugdale, Richard C., Ph.D., Research Professor of Chemical and Biological Oceanography
- Duxbury, Alyn C., Ph.D., Research Assistant Professor of Physical Oceanography
- Echols, Ronald J., Ph.D., Research Assistant Professor of Geological Oceanography
- English, T. Saunders, Ph.D., Associate Professor of Biological Oceanography
- Fleming, Richard H., Ph.D., Professor of General Oceanography (Physical)
- Kelley, James C., Ph.D., Assistant Professor of Geological Oceanography
- Larsen, Lawrence H., Ph.D., Research Assistant Professor of Physical Oceanography
- Lewin, Joyce C., Ph.D., Associate Professor of Biological Oceanography
- Ling, Hsin-Yi, Ph.D., Research Assistant Professor of Geological Oceanography
- Lister, Clive R. B., Ph.D., Research Assistant Professor of Geological Oceanography and Geophysics
- McAlister, William B., Ph.D., Visiting Assistant Professor of Physical Oceanography
- McManus, Dean A., Ph.D., Associate Professor of Geological Oceanography
- Merrill, Ronald T., Ph.D., Assistant Professor of Geological Oceanography and Geophysics
- Richards, Francis A., Ph.D., Professor of Chemical Oceanography
- Smith, J. Dungan, Ph.D., Assistant Professor of Geological Oceanography and Geophysics
- Sternberg, Richard W., Ph.D., Assistant Professor of Geological Oceanography
- Taylor, Peter B., Ph.D., Assistant Professor of Biological Oceanography
- Whetten, John T., Ph.D., Associate Professor of Geological Oceanography and Geology

Zoology:

- Edmondson, Walles J., Ph.D., Professor of Zoology
- Orians, Gordon H., Ph.D., Professor of Zoology

Geography Department:

- Cooley, Richard A., Ph.D., Associate Professor of Resource Policies and Utilization
- Marts, Marion E., Ph.D., Vice Provost; Director, Summer Quarter; Professor of Geography and Urban Planning
- Ullman, Edward L., Ph.D., Professor of Urban and Transportation Geography
- Fleming, D. K., Ph.D., Assistant Professor of Geography

International Business

- Kolde, Endel, J., D.B.A., Professor of International Business and Marketing

School of Law

- Johnson, Ralph W., LL.B., Professor of Law
- Henderson, Don Fenno, Ph.D., Professor of Law

To obtain further information, address all inquiries directly to:

Dr. Stanley R. Murphy
Director, Division of Marine Resources
University of Washington
Seattle, Washington 98105

WESTERN WASHINGTON STATE COLLEGE
Bellingham, Washington

The marine sciences courses are offered in the departments of Biology and Geology which occupy separate floors of the Haggard Hall of Science. This building has facilities such as refrigerated salt water aquaria and several walk-in cold rooms for holding marine organisms. The two departments share machine shop and electronics shop facilities for the construction and maintenance of instruments. An electron microscope lab and a well equipped computer center are also available for use.

The Biology Department maintains a small marine research laboratory on Lummi Island which is about 45 minutes by car and ferry from the campus. Facilities at this site include large outside holding tanks supplied with running sea water and a small research laboratory which has been designed for the study of the effects of cycled environmental variables (salinity, temperature, and photoperiod) on marine organisms. A 20-foot open work skiff is available for light dredging and trawling operations in protected waters. The College has just purchased a 71 acre marine lab site near Anacortes for future development.

The B.A. and M.S. degrees in Biology and Geology with a concentration in marine science are offered by the college. At the B.A. level students take a core offering and may choose marine courses as part of the elective program. For the M.S., students are able to elect course work related to marine biology or geology and may undertake thesis work in marine science.

The following courses are offered in conjunction with the above programs:

Department of Biology

240	Marine Biology	3
300*	Special Projects in Biology	1–2
301	Ecology	5
400*	Special Projects in Biology	2–5
403	Physiological Ecology of Marine Animals	5
406	General Oceanography	3
500*	Special Projects in Biology	2–5
501*	Thesis Research	4–9
503*	Advanced Topics in Ecology	4
504	Ecological Instrumentation	3
577*	Advanced Topics in Physiology	4
583*	Advanced Topics in Biosystematics	4
456	Algae	5
461	Marine Invertebrate Zoology	5

Department of Geology

310	Geomorphology	5
316	Paleontology	5
340	Geological Oceanography	3
400	Special Projects in Geology	2–5
426	Micropaleontology	4
436	Paleoecology	4
446	Clay Mineralogy	4
507	Coastal Geology	4
516	Problems in Biostratigraphy	3
524	Sedimentary Petrology and Geochemistry	3
546	Geology of Clays	3

The instructional staff for the courses listed above consists of the following:

Department of Biology

Broad, A. Carter, Ph.D., Chairman and Professor of Biology
Dube, Maurice A., Ph.D., Associate Professor of Biology

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*These courses may be offered with a marine emphasis.

Department of Biology—*Continued*

Heath, Wallace G., Ph.D., Associate Professor of Biology
Mason, David T., Ph.D., Assistant Professor of Biology
Ross, June P., Ph.D., Associate Professor of Biology
Schneider, David E., Ph.D., Assistant Professor of Biology

Department of Geology

Easterbrook, Don J., Ph.D., Professor of Geology and Chairman
Pevear, David R., Ph.D., Assistant Professor of Geology
Rahm, David A., Ph.D., Associate Professor of Geology
Ross, Charles A., Ph.D., Professor of Geology
Schwartz, Maurice L., Ph.D., Assistant Professor of Geology
Swineford, Ada, Ph.D., Associate Professor of Geology

To obtain further information, address all inquiries directly to:

Department of Biology: A. C. Broad, Chairman
Department of Biology
Western Washington State College
Bellingham, Washington 98225

Department of Geology: Don J. Easterbrook, Chairman
Department of Geology
Western Washington State College
Bellingham, Washington 98225

UNIVERSITY OF WISCONSIN
Madison, Wisconsin

In the past year, the marine sciences facilities at the University of Wisconsin have been substantially expanded. The newly completed Meteorology & Space Sciences building has one floor, about 5,500 square feet, devoted to physical oceanography. The administrative offices of the all-Campus Marine Studies Center are also located in this building. The Marine Research Laboratory, which is the natural science arm of the Marine Studies Center, is located in a separate building with 7,000 square feet of space. A new Engineering Research Building, to be completed in September, 1969, will have one floor devoted to ocean engineering.

In addition to these new laboratory facilities, the following facilities continue to be used for marine-related research and graduate training:

Laboratory of Limnology–hydrobiology
Engineering Hydraulics Laboratory–fluid mechanics and modelling
Water Chemistry Laboratory–chemical oceanography
Instrumentation Systems Center–instrumentation
Geophysics Research Center–marine geophysics

The Oceanic Institute in Hawaii, through a working agreement with the University of Wisconsin, provides field and laboratory facilities for Wisconsin faculty and students. The Center for Great Lakes Studies at the University of Wisconsin-Milwaukee, with its diversified research facilities, is available to both staff and students. Extensive use is made of United States Coast Guard vessels on the Great Lakes.

Each laboratory facility is fully-equipped and the specialized equipment ranges from wave tanks and aquaria to numerous small boats up to 30 feet in length and fixed and barge-borne micrometeorological towers.

Supporting the above facilities is the University Computing Center. Available for use to all marine scientists are an IBM 1460, a CDC 3600, a CDC 1604, Univac 1108, plus appropriate software. The main library harbors more than one million volumes and there are specialized libraries for Earth Sciences (including Oceanography), Agriculture and Life Sciences, Biology, and Engineering.

The following degrees are offered in Marine Science:

1. **Ph.D. in Oceanography and Limnology; Minor in Oceanography and Limnology for Ph.D. in other fields.** The graduate training program in oceanography is administered by the Interdepartment Committee on Oceanography and Limnology. The program is based on the premise that oceanography and limnology should be considered together as an integrated field requiring a broad base in fundamental disciplines plus specialization in the application of one particular discipline to the hydrosphere. A student in the program will be required to have had mathematics through calculus and one year each in chemistry, and physics. In addition, the student will be required to take advanced work in marine and aquatic related subjects in two or more departments and will specialize in a particular aspect of oceanography and limnology, i.e., physical, chemical, geological, or biological. Study plans will be individually tailored for each student by a committee of three professors. At least one semester of marine experience is required. This is to be broadly interpreted to include research participation at a marine station, sea duty, duty on a floating ice island, systematic aerial measurements of marine phenomena or equivalent.

2. **College of Engineering** offers a **M.S. and Ph.D. with an option in Ocean Engineering.** Course programs are individually tailored for the students in a manner similar to that discussed above for the Oceanography and Limnology degree.

The following courses are offered in conjunction with the above programs:

Department of Botany

330	Algae	Sp	3
450	Principles of Plant Ecology	Sp	3

Department of Civil Engineering			
406	Remote Sensing of the Environment	F	3
602	Hydrodynamics	F	3
612	Open Channel Hydraulics	Sp	3
621	Hydrology	F, Sp	3
622	Water Resources Engineering	Sp	3
661	Ocean Dynamics	F	4
66–	Ocean Environment	F	3
66–	Technology of Ocean Operations	Sp	3
669	Ocean Engineering Seminar	Sp	1–2
863	Free Surface Flow II	Sp	3
960	Hydraulic Engineering and Fluid Mechanics Seminar	Sp	1
—	Diffusion and Dispersion	Sp	3
Department of Entomology			
532	Aquatic Insects	Sp	3
Department of Geology and Geophysics			
130	Survey of Oceanography	F, Sp	3
525–526	Micropaleontology	Alternate years	3
533	Geochemistry of Sediments	F	3
535	Physical Aspects of Sedimentation	Sp	2
537	Geological Oceanography	F	3
538	Recent Marine Sediments	Sp	3
652	Wave Propagation	F	3
671	Marine Geophysics	Alt. Sp	3
777	Sea Floor Geological Processes	F	3
977	Seminar in Sedimentation and Geological Oceanography	Sp	2
School of Law			
845	Water Rights Law		2
918	International Law		2
919	International Organizations		2
928	Water Law		2
Department of Meteorology			
403	Micrometeorology	Sp	3
460	Physical Oceanography	F	3
461	Physical Oceanography II	Sp	3
501	General Meteorology I	F	5
502	General Meteorology II	Sp	5
551	Geophysical Fluid Dynamics	Sp	3
7—	Dynamic Oceanography I		3
7—	Dynamic Oceanography II		3
774	Problems in Oceanography	Sp	2
861	Problems of Viscous Flow	F	2 or 3
862	Problems of Turbulent Flow	Sp	2 or 3
960	Seminar: Oceanography	Sem	1 or 2
Department of Political Science			
504	Science and Government	Sem	3
Department of Urban/Regional Planning			
449	Government and Natural Resources	Sem	3
865	Water Resources Institutions and Policies	Sp	3
965	Seminar in River Basin Planning	F	2 or 3
966	Seminar in Water Resources Planning	Sp	2 or 3

Department of Water Chemistry

642	Water Analysis	F	3
644	Water Chemistry	F	3
645	Water Analysis–Intermediate	F	3
646	Marine Chemistry	Sp	2
770	Advanced Water Chemistry	Sp	3
771	Advanced Techniques of Water Analysis	F	3
772	Advanced Techniques of Water Analysis	Sp	3
773	Organic Water Chemistry	F	2
962	Water Chemistry Seminar	F, Sp	1

Department of Zoology

300	General Invertebrate Zoology	Sp	3
500	Ecology	F	3
510	Ecology of Fishes	Sp	3
512	Biology of the Plankton	Sp	2 or 3
515	Limnology–Conservation of Aquatic Resources	F	2
615	Biology of Aquatic Populations	F	3
—	Hydrobiology	F	3
955	Seminar: Limnology	F, Sp	1

The instructional staff for the courses listed above consists of the following:

Department of Botany

Cottam, Grant, Ph.D., Professor of Botany
Gerloff, Gerald C., Ph.D., Professor of Botany
Loucks, Orie L., Ph.D., Professor of Botany

Department of Civil Engineering

Clapp, James L., Ph.D., Associate Professor of Civil Engineering
Green, Theodore (See Meteorology)
Hoopes, John A., Ph.D., Associate Professor of Civil Engineering
Huff, Dale D., Ph.D., Assistant Professor of Civil Engineering
Lenz, Arno T., Ph.D., Professor of Civil Engineering
Lettau, Heinz H. (See Meteorology)
Monkmeyer, Peter L., Ph.D., Associate Professor of Civil Engineering
Rohlich, Gerard A., Ph.D., Professor of Civil Engineering
Saul, William E., Ph.D., Associate Professor of Civil Engineering
Villemonte, James R., Ph.D., Professor of Civil Engineering

Department of Engineering Mechanics

Huang, T. C., Ph.D., Professor of Engineering Mechanics

Department of Entomology

Hilsenhoff, William L., Ph.D., Associate Professor of Entomology

Department of Geology and Geophysics

Clay, Clarence S., Ph.D., Professor of Geology and Geophysics
Clark, David L., Ph.D., Professor of Geology and Geophysics
Dott, Robert H., Ph.D., Professor of Geology and Geophysics
Meyer, Robert P., Ph.D., Professor of Geology and Geophysics
Moore, J. Robert, Ph.D., Professor of Geology and Geophysics
Steinhart, John, Ph.D., Professor of Geology and Geophysics

Department of Mechanical Engineering

Harker, Ralph J., M.S., Professor of Mechanical Engineering
Livermore, Donald F., Ph.D., Professor of Mechanical Engineering
Seirig, Ali A., Ph.D., Professor of Mechanical Engineering

Department of Meteorology

Bryson, Reid A., Ph.D., Professor of Meteorology
Csanady, Gabriel T., Ph.D., Professor of Meteorology
Green, Theodore, Ph.D., Associate Professor of Civil Engineering and Meteorology
Hastenrath, Stefan L., Ph.D., Associate Professor of Meteorology
Lettau, Heinz H., Ph.D. habil., Professor of Civil Engineering and Meteorology
Ragotzkie, Robert A., Ph.D., Professor of Meteorology
Stearns, Charles R., Ph.D., Assistant Professor of Meteorology
Young, John A., Ph.D., Assistant Professor of Meteorology

Department of Minerals and Metals

Heins, Robert W., Ph.D., Associate Professor of Mining Engineering

Department of Nuclear Engineering

Huston, Norman E., Ph.D., Professor of Nuclear Engineering

Department of Political Sciences

McCamy, James L., Ph.D., Professor of Political Science

Department of Urban/Regional Planning

Clarenbach, Fred A., Ph.D., Professor of Urban/Regional Planning
Fox, Irving K., M.A., Professor of Urban/Regional Planning

Department of Water Chemistry

Armstrong, David E., Ph.D., Assistant Professor of Water Chemistry
Lee, G. Fred, Ph.D., Professor of Water Chemistry

Department of Zoology

Fraser, Lemuel A., Ph.D., Professor of Zoology
Hasler, Arthur D., Ph.D., Professor of Zoology
Henderson, H. Francis, Ph.D., Assistant Professor of Zoology
Magnuson, John J., Ph.D., Associate Professor of Limnology

School of Law

Baldwin, Gordon B., Llb., Professor of Law
Bilder, Richard, Llb., Professor of Law
MacDonald, James B., J.D., Professor of Law
Runge, Carlisle P., J.D., Professor of Law

To obtain further information, address all inquiries directly to:

Professor Robert A. Ragotzkie
Chairman, Oceanography & Limnology Committee
University of Wisconsin
1225 West Dayton Street
Madison, Wisconsin 53706

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

The Institution has been conducting oceanographic research since its founding in 1930. Today, it operates one of the largest oceanographic research complexes in the country, maintaining waterfront laboratory and docking facilities in Woods Hole on a year-around basis. Well equipped laboratories for research in biological, chemical, geological, geophysical and physical oceanography, and ocean engineering are currently in operation. These are backed up by available computer services through the Institution's own Information Processing Center and the combined library resources of the Institution, the Marine Biological Laboratory, and the Bureau of Commercial Fisheries Biological Laboratories, also located in Woods Hole. These extensive land-based facilities serve as the base of operation of the Institution's well-equipped, experienced oceanographic research fleet. **ATLANTIS II**, newest member of the fleet, was built in 1963 to the Institution's design specifically for oceanographic research. She is 210 feet long, has accommodations for a scientific party of 25 and four fixed laboratories, and carries such special features as anti-roll tanks, a bow thruster, and underwater observation ports. The **CHAIN**, 213-foot former Navy salvage ship, converted for oceanographic work in 1958, is also equipped for work on the high seas. **GOSNOLD**, a 99-foot ex-cargo vessel with portable laboratory units on deck, is outfitted for work on the continental shelf. **ASTERIAS**, a 40-foot coastal dragger, is equipped for inshore and estuarine work. A four-engine C54Q, converted for meteorological and airborne oceanic studies and a single-engine Helio-Courier useful for slow speed observation runs, are also operated by the Institution.

The following degrees are offered:

1. **Ph.D. and Sc.D.** offered jointly by M.I.T. and W.H.O.I.
2. **Ph.D. in Oceanography** offered by the Woods Hole Oceanographic Institution starting in 1969.

For the doctoral degree a student is required to pursue a program of advanced study leading to a general examination; to demonstrate ability in research by presentation and defense of a thesis; to meet language requirements (ability to read scientific literature in two acceptable foreign languages, or more extensive reading and speaking knowledge of one), and certain residence requirements.

To supply the breadth of outlook essential for the scientist concerned with the oceans as an interacting system, the Woods Hole Oceanographic Institution undertakes to provide, with courses, seminars, assigned readings and research in depth in special skills, the integrative outlook necessary for progress in the science of oceanography. Students entering the study of oceanography will be able to work in the environment created by mature research workers dedicated to solving problems of the seas without restraint of traditional special subject boundaries, but also under a rigorous intellectual regime which will necessitate the development of high competence in special selected areas.

Students working at the Institution must be capable of self-directed work. Major emphasis is placed on reading, experience in research, seminars and discussions. Relatively few courses are offered in a formal sense. Specialized and advanced basic course work may be undertaken as needed for proper intellectual development at recognized universities in the area by special arrangement.

The graduate study programs offered lead to the doctor's degree in oceanography awarded by the Institution or jointly with the Massachusetts Institute of Technology. The Institution also has an informal cooperative arrangement with Yale University, making possible cross-registration for courses and advanced study not available at Woods Hole. Similar arrangements with other institutions of higher learning may be exercised as needed.

While for administrative purposes the Institution is comprised of five departments, the education program centers around problems and individuals. The degree program is founded on the principle that oceanography is an interdisciplinary science, and therefore an interdisciplinary approach is virtually mandatory. Thus, individual scientists and engineers from all departments and disciplines represented at the Institution are involved in the program. A student does not enroll in any one department, but rather in the total program and is free to choose his area of specialization without restriction of departmental barriers.

To provide the broadly-based education in oceanography deemed necessary, the following five core courses are offered. Most other instruction is carried out in special seminars and through close research supervision by individual staff members. Seminar offerings will depend largely on the interests of the students.

I. Marine Geology and Geophysics

This course will be taught in two parts. The first part will be an introduction to the geology of the sea floor. Concepts rather than details are stressed. Current ideas on the origin and history of the ocean basin and the continental margin will be emphasized. Discussion will also be devoted to beaches and the nearshore environments, and to the sediments and rocks of the ocean floor.

The second part will be primarily concerned with the physics of the earth. Emphasis will be placed on the solid earth, and the recent theories concerning the origin of continents and oceans.

Students should have had the equivalent of an undergraduate course in general geology or be prepared to undertake extra assigned study.

II. Chemical Oceanography

The course will stress wide coverage of the field emphasizing concepts rather than details. Topics to be covered include major ion composition, ionic species and equilibrium concepts, trace elements, the carbonate and silicate systems, dissolved gases, stable isotopes, radionuclides, and organic matter in the sea. The geochemistry of the sediments including the molecular interactions between clay minerals, carbonates and the dissolved and particulate organic matter will be reviewed. The course will integrate the marine geochemistry of the lithosphere, atmosphere and biosphere.

III. Biological Oceanography

The special adaptations or organisms for life in the sea and the impact of biological processes on the non-living components of the marine environment provide the core of the biological oceanography course. Among the ideas emphasized will be the cycling of energy and matter through the marine ecosystem, and the factors regulating the abundance, distribution, and community organization of marine microorganisms and metazoans. Through laboratory and shipboard work the student will be introduced to the marine environment and to the methods of studying the organisms and biological processes that occur in the sea.

IV. Physical Oceanography

The movement and physical structure of the ocean waters will form the core of the physical oceanography course. Topics to be covered will include a description of the general oceanic circulation and its dynamics, the interaction between the ocean and the atmosphere, and the physical properties of sea water. The subjects will be related to current research studies at W.H.O.I. Throughout, emphasis will be given to research methods: collecting, handling and analyzing oceanographic data, and the limitations of oceanographic tools.

A background in undergraduate physics and mathematics is a prerequisite.

V. Engineering Materials in the Ocean Environment

Many materials foreign to the ocean environment are introduced into it as aids to observation and measurement and to suit other needs of man. In addition, the sea itself can become an engineering material. This general course emphasizes the interaction of materials properties and the environment. It includes criteria for materials selection and the effects of this choice on observation and measurement of phenomena at their air-sea interface, within the sea, at the land-sea interface and beneath the sea floor. Applications include biology, chemistry, electrical and electronic components, hydromechanics including underwater acoustics, magnetics, optics, radiation, sealants, structure, thermodynamics, thermometry and high and low temperature.

This course is intended for those having interest in any branch of oceanography.

The instructional staff is drawn from the 150 members of the Scientific and Technical Staff of the Institution. A complete listing is given in the Institution's Annual Announcement, obtainable on request. In addition, ready access to the listed faculties of cooperating universities is available (see M.I.T. and Yale). Listed below are the W.H.O.I. department chairmen.

Department of Ocean Engineering
Daubin, Scott Crittenden, Ph.D., Senior Scientist
Department of Physical Oceanography
Fofonoff, Nicholas Paul, Ph.D., Senior Scientist
Department of Geology & Geophysics
Hays, Earl E., Ph.D., Senior Scientist
Department of Chemistry
Hunt, John M., Ph.D., Senior Scientist
Department of Biology
Ryther, John H., Ph.D., Senior Scientist

To obtain further information, address all inquiries directly to:

Dr. H. Burr Steinbach
Dean of Graduate Studies
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

OTHER INSTITUTIONS OFFERING COURSES IN MARINE SCIENCE

Gulf Coast Technical Institute, Mississippi State University
University of Houston

CONSORTIA IN THE MARINE SCIENCES

GULF COAST RESEARCH LABORATORY
Ocean Springs, Mississippi

The Gulf Coast Research Laboratory offers summer courses in marine biology and marine geology as well as year-round instruction and research programs leading to the M.S. and Ph.D. degrees in such areas as Biological Electron Microscopy, Morphology, Microbiology, Taxonomy, Biochemistry, Fisheries Biology, Marine Ecology, Bioenergetics and Aquatic Systems.

The Laboratory is a non-profit educational institution and is affiliated with the following colleges and universities:

- Belhaven College
- Delta State College
- Millsaps College
- Mississippi College
- Mississippi State College for Women
- Mississippi State University
- University of Mississippi
- University of Southern Mississippi
- William Carey College
- Auburn University
- Bowling Green University
- Jamestown College
- Lambuth College
- Louisiana State University
- McNeese State College
- Memphis State University
- Northeast Louisiana State College
- Northwestern State College of Louisiana
- Northwest Missouri State College
- Southwest Missouri State College
- Southwestern Oklahoma State College
- Tennessee Technological University
- Tennessee Wesleyan College
- Troy State College
- Westmar College

For further information on any of the participating universities or colleges, please contact the university or college directly.

For further information on graduate research, please contact the Registrar, Gulf Coast Research Laboratory, Ocean Springs, Mississippi 39564.

365-212 O-69—12

GULF UNIVERSITIES RESEARCH CORPORATION
College Station, Texas

The Gulf Universities Research Corporation is a non-profit consortium of 17 universities and research institutes located near, and sharing interests in, the Gulf of Mexico and persons living on the periphery of the Gulf.

The aims of the Corporation are research, education, and public service, in pursuit of which the corporation will establish centralized research facilities in scientific areas of interest to its membership and in areas where the needs for supporting services and equipment are on such a large scale as to make single university ownership impractical or undesirable. Present interest of the corporation is in basic and applied research in marine science, including marine meteorology, physical oceanography, marine biology, marine geology, marine geophysics, pollution, remote sensing, and chemical oceanography.

The participating universities and research institutes are:

- Florida State University
- Louisiana State University
- Rice University
- Southern Methodist University
- Southwest Center for Advanced Studies
- Southwest Research Institute
- Texas A&M University
- Texas Christian University
- Texas Technological College
- Tulane University
- University of Alabama
- University of Florida
- University of Houston
- University of Miami
- University of Southern Mississippi
- University of Texas
- University of Mexico

Corporation Headquarters are at 227 System Building, College Station, Texas 77843.

For further information on any of the participating universities or research institutes, please contact the university or institute directly.

MARINE SCIENCE CONSORTIUM OF PENNSYLVANIA COLLEGES AND UNIVERSITIES

Participating institutions:

Bloomsburg State College, Bloomsburg, Pa. 16912
Community College of Philadelphia, Philadelphia, Pa. 19107
Edinboro State College, Edinboro, Pa. 16412
Indiana University of Pennsylvania, Indiana, Pa. 15701
Kutztown State College, Kutztown, Pa. 19530
Millersville State College, Millersville, Pa. 17551 (Administrative Center)
Shippensburg State College, Shippensburg, Pa. 17257
Slippery Rock State College, Slippery Rock, Pa. 16057
West Chester State College, West Chester, Pa. 19380

Each of the participating institutions offers one or more courses in oceanography, for which classroom facilities, laboratory space, modest library support and access to computers are available on the various campuses.

In addition, the Consortium operates, through a non-profit corporation, the **"Delaware Bay Marine Science Center,"** in Lewes, Delaware. This facility, a former U.S. Coast Guard Station, sleeps up to 40 students and faculty. Several classrooms, wet and dry laboratories, boat houses, workshops and garages as well as docking facilities for small vessels are part of the Center.

A 60 x 12-foot fully equipped, air-conditioned mobile laboratory is available. This trailer consists of a diving locker, sedimentation lab, weighing and microscope room, drafting room, office and conference room.

Vessels include:

(1) a 34 x 15 foot research catamaran, with center well, traveling overhead gantry, hydrowinch, radar, loran-C, depth-recorder, and VHF radio. Propulsion is by twin inboard-outboard diesels (90 H.P. each), and the action radius is about 900 miles.

(2) a 38-foot converted Sportfisher, SANDPEBBLE, with davits and handwinches, depth-sounder and VHF radio, one 250 H.P. gasoline engine, single screw.

(3) a 30 foot converted lobster fisher, LYDIA B., with A-frame, handwinches, depth-sounder, diving platform and hookah-diving equipment, one 150 H.P. gasoline engine, single screw.

(4) two small boats are used for nearshore work.

A 12 passenger sportsvan is available, through a grant by the Penn. Science and Engineering Foundation, for fieldtrips along the coast.

Presently no degrees in the Marine Sciences are offered. Undergraduate degrees consist of **B.A. and B.S. in Education, Biology, Geology, Geography, Earth and Space Science**, etc. At graduate level, the **M.Ed. in Science** is available.

In participating institutions with a divisional structure, marine science courses are restricted to the Division of Science. On the departmental level, oceanography courses are offered in the departments of geography, geology, geoscience and earth and space science (depending on the particular institution), and marine biology courses in the biology department.

All of the following courses are offered during the 3 week summer session at DBMSC. Those also offered at participating institutions during the year are so indicated.

Undergraduate Courses

Mar. Sci. 110	Introductory Oceanography	Su	3
	Millersville State College	Sp	
	Indiana University of Pennsylvania		
	Kutztown State College		
	Slippery Rock State College		
Mar. Sci. 211	Field Methods in Nearshore and Estuarine Oceanography	Su	3
Mar. Sci. 221	Invertebrate Zoology	Su	3
	Millersville State College	Sp	
	Kutztown State College		

Undergraduate Courses—*Continued*

Mar. Sci. 241	Marine Biology	Su	3
Mar. Sci. 260	Marine Ecology	Su	3
Mar. Sci. 331	Chemical Oceanography	Su	3
	Millersville State College	F	
Mar. Sci. 362	Marine Geology	Su	3
	Millersville State College	Sp	
Mar. Sci. 364	Physical Oceanography	Su	3
Mar. Sci. 420	Marine Micropaleontology	Su	3
Mar. Sci. 457	Marine Geophysics	Su	3
Mar. Sci. 500	Problems in Marine Science	Su	3–6

Graduate Courses

For information about graduate courses, including N.S.F. summer institutes, contact the Marine Science Consortium.

The instructional staff for the courses listed above consists of the following:

Bloomsburg State College
Geology Department
Lauffer, James, M.S., Assistant Professor, Geology
Community College of Philadelphia
Biology Department
Schmidt, Eugene, M.S., Associate Professor, Physiology and Marine Biology
Edinboro State College
Geology Department
Wegweiser, Arthur, Ph.D., Chairman, Department of Geology, Professor, Geology
Indiana University of Pennsylvania
Geoscience Department
Prince, Paul A., M.A., Associate Professor, Oceanography and Meteorology
Biology Department
Liegey, Frank, Ph.D., Chairman, Department of Biology, Vice-President of Marine Science Consortium, Professor, Microbiology, Cell Physiology
Kutztown State College
Geography Department
Mobley, Mary, M.S., Assistant Professor, Oceanography
Millersville State College
Biology Department
McCormick, J. Michael, Ph.D., Assistant Professor, Marine Biology
Earth & Space Science Department
Davis, Donald R., Ph.D., Assistant Professor, Marine Chemistry, Water Pollution
Oostdam, Bernard L., M.S., President, Marine Science Consortium, Associate Professor, Oceanography, Marine Geology
Shippensburg State College
Geography Department
Stratton, James F., M.A.T., Assistant Professor, Oceanography
Slippery Rock State College
Geology Department
Bushnel, Kent, Ph.D., Associate Professor, Geophysics
Sutherland, Jeffery C., Ph.D., Associate Professor, Geology
Szucs, F. K., Sc.D., Chairman, Department of Geology, Professor, Geochemistry
West Chester State College
Biology Department
Jones, Harry, M.S., Assistant Professor, Ecology
Chemistry Department
Greenberg, Seymour S., Ph.D., Professor, Geology

Admission to summer sessions requires:

1. Acceptance by the Admission Committee of the Consortium prior to April 15

   Inquiries to be directed to:

   Prof. B. L. Oostdam
   Marine Science Consortium
   Admission Committee
   P. O. Box 43
   Millersville, Pennsylvania 17551

2. Admission to one of the participating institutions

   Contact the Admission Office or the Dean of Academic Affairs of the appropriate participating institution.

Moss Landing Marine Laboratories
California State Colleges
Moss Landing (Monterey County), California

Five California State Colleges (at Fresno, Hayward, Sacramento, San Francisco, and San Jose) jointly operate this seaside facility as a year-around center for upper division and graduate level education and research in the marine sciences. An average of 30 units of course work, plus Master's research and thesis, are provided every term (fall, spring, summer). The Laboratories face west on Monterey Bay at the point of origin of a deep submarine canyon. To the east, Moss Landing Harbor opens upon the diversified intertidal marsh and mudflat habitats of Elkhorn Slough. The buildings provide 14,000 square feet of classroom, research, laboratory, office, and library space, equipped to support the diversified curriculum and research needs of a multidisciplinary operation. A fleet of skiffs and small boats (8 to 24 feet) provide access to the nearshore marine and estuarine environments upon which the Laboratories focus primary instructional and research emphasis. Cooperative arrangements with governmental and privately owned vessels provide access to deeper waters. The Moss Landing Marine Laboratories began operation in 1966, and have expanded rapidly to near capacity (approximately 60 students, half graduate and half upper division undergraduate). Acquisition (1968) of five acres of adjacent land will permit further expansion of physical facilities as funding becomes available.

Since the Moss Landing Marine Laboratories are an integral part of five separate supporting colleges, degrees are earned through those colleges. Baccalaureate and Master's degrees in the basic sciences (e.g., Biology, Chemistry, Geology, Meteorology), may include concentrations in the marine field, to include one or more semesters of study at the Moss Landing Marine Laboratories. While details differ in the several institutions, the following general notes apply.

1. **B.A. or B.S. in Biology** (or Botany, Conservation, Zoology for some Colleges). Marine Sciences requirements at Moss Landing Marine Laboratories include General Oceanography, Marine Ecology, Marine Science Techniques, and Literature of the Marine Sciences, plus electives appropriate to the major interest. In the California State Colleges, a minimum of 124 units are required for the bachelor's degree, of which 45 must be in broad general education areas.
2. **B.A. or B.S. in Geology**. The marine sciences concentration will be similar to that for biology, with recommended electives including Marine Meteorology, Marine Biogenic Sediments, and General Oceanography.
3. **M.S. or M.S. in Biology, Geology, Meteorology, or Chemistry**. Thirty graduate units, to include six to ten units of required core courses, and research and thesis are required for the Master's degree. Some institutions also require reading competence in a foreign language. The Marine Sciences concentration usually includes a full year of work at the Moss Landing Marine Laboratories, with research and thesis on a marine environmental topic.

The Moss Landing Marine Laboratories curriculum supports two primary disciplines—marine biology and marine geology—for all five participating colleges. While labels differ at these colleges, majors served are in the baccalaureate and master's degree programs in biology and geology. Occasional course offerings also support majors in meteorology (San Jose State College), geography, and engineering. Special summer workshops and year-around seminar and special topics courses are designed for in-service marine sciences instruction of teachers at all levels.

The following courses are offered in conjunction with the above programs:

101	General Oceanography	F, Sp, Su	4
102	Marine Science Techniques	F, Sp, Su	1
111	Zoology of Marine Vertebrates	F, Sp, Su	4
115	Marine Invertebrate Physiology	F	4
121	Marine Invertebrate Zoology	F, Sp, Su	4
128	Marine Invertebrate Embryology	Su*	4
131	Marine Algology	Sp, Su	3

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*Offered in alternate years.

133	Micropaleontology	Sp*	3
134	Coastal Geomorphology	Su*	3
135	Marine Meteorology	F, Sp	3
137	Marine Biogenic Sediments	F	3
141	Geological Oceanography	Sp, Su	4
160	Ichthyology	Su	4
161	Marine Ecology	F, Sp, Su	3
180	Special Problems in the Marine Sciences	F, Sp, Su	1–4
181	Literature of the Marine Sciences	F, Sp, Su	1
196	Marine Science Diving	F, Sp, Su	2
201	Principles of the Marine Sciences	Sp	3
255	Ecology of the Gulf of California	Sp*	4
260	Seminar in Regional Geography	Sp*	3
261	Behavior of Marine Animals	Sp	4
277	Human Geography and Ecology of the Monterey Bay Area	F	3
285	Graduate Seminar	F, Sp, Su	1
298	Research in the Marine Sciences	F, Sp, Su	1–4
299	Master's Thesis	F, Sp, Su	1–4

The instructional staff for the courses listed above consists of the following:

Harville, John P., Ph.D., Director, Moss Landing Marine Laboratories, and Professor of Biology, San Jose State College

Department of Biological Sciences

Bell, Charles W., Ph.D., Associate Professor of Biology, San Jose State College
Eickstaedt, Lawrence L., M.A., Assistant Professor of Biology, California State College, Hayward
Jensen, James B., M.A., Assistant Professor of Biology, California State College, Hayward
Meeker, Gary L., Ph.D., Assistant Professor of Biological Sciences, Sacramento State College
Morejohn, G. Victor, Ph.D., Professor of Biology, San Jose State College
Nybakken, James W., Ph.D., Associate Professor of Biological Sciences, California State College, Hayward
Tomlinson, Jack T., Ph.D., Professor of Biology, San Francisco State College
Yarberry, Edgar L., Ph.D., Assistant Professor of Biology, San Jose State College

Department of Geology

Arnal, Robert E., Ph.D., Professor of Geology and Oceanography, San Jose State College
Pestrong, Raymond, Ph.D., Assistant Professor of Geology, San Francisco State College
Stevens, Calvin H., Ph.D., Assistant Professor of Geology, San Jose State College
White, Stanton M., Ph.D., Assistant Professor of Geology, Fresno State College

Department of Meteorology

Read, Robert G., M.S., Associate Professor of Meteorology, San Jose State College

Department of Geography

Gordon, Burton L., Ph.D., Professor of Geography, San Francisco State College
Norsworthy, Stanley F., M.A., Assistant Professor of Geography, Fresno State College

To obtain further information, address all inquiries directly to:

John P. Harville, Director
Moss Landing Marine Laboratories
P. O. Box 223
Moss Landing, California 95039

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*Offered in alternate years.

CURRICULA IN OCEAN ENGINEERING

UNIVERSITY OF ALASKA
College, Alaska

(For a description of the facilities and the marine science program at the University of Alaska, please refer to the University's listing in the Marine Sciences section of this publication.)

The University offers the **M.S. degree in Ocean Engineering.**

The program is coordinated by an interdisciplinary committee of the University composed of selected staff members from the academic colleges and research institutes involved with ocean science. At the M.S. level, the program emphasizes ocean-related course work in ocean engineering. However, additional graduate courses are recommended in the area of the student's undergraduate training to assure a high level of competence.

The minimum credit requirements for the M.S. degree are 30 graduate credits (9 of which may be thesis credits). One summer of approved field work may be substituted for a thesis. Course requirements—OCN 620, OCE 670, OCE 672, OCE 674, and OCE 680, and a minimum of six credits of additional course work to be selected by the student's committee.

The following courses are offered in conjunction with this program:

Electrical Engineering			
E. E. 693	Special Topics (Instrumentation)	F	Credits Arranged
E. E. 694	Special Topics (Electronics)	Sp	Credits Arranged
Engineering Management			
E. M. 605	Advanced Engineering Economy	F	3
E. M. 611	Engineering Management	F	3
E. M. 612	Engineering Management	Sp	3
E. M. 613	Engineering Management	Sp	3
Civil Engineering			
C. E. 603	Arctic Engineering	F	3
C. E. 620	Civil Engineering Construction	F	3
C. E. 631	Advanced Structural Analysis	F	3
C. E. 632	Advanced Structural Design	Sp	3
C. E. 644	Hydraulic Engineering	Sp	3
OCE 670	Waves and Tides		3
OCE 672	Underwater Acoustics		3
OCN 674	Environmental Hydrodynamics		3
OCE 676	Coastal Engineering		3
OCE 680	Ocean Engineering Field Work		3

The instructional staff for the courses listed above consists of the following:

Behlke, Charles E., Ph.D., Dean of College of Mathematics, Physical Sciences and Engineering; Professor of Engineering

Goebel, Davis, Jr., Ph.D., Associate Professor of Electrical Engineering; Arctic Environmental Engineering Laboratory

Kinney, Patrick J., Ph.D., Assistant Professor of Marine Science; Chemical Engineering

Peyton, Harold R., Ph.D., Professor of Engineering; Arctic Environmental Engineering Laboratory

To obtain further information, address all inquiries directly to:

Dr. Donald W. Hood, Director
Institute of Marine Science
University of Alaska
College, Alaska

UNIVERSITY OF CALIFORNIA
Berkeley, California

Facilities for research within the University are located on the Berkeley campus and the nearby Richmond Field Station located on the shores of San Francisco Bay. Oceanographic research vessels are available in the bay area through working arrangements with the U. S. Geological Survey and the U. S. Bureau of Mines and in San Diego through the marine facilities of the Scripps Institution of Oceanography. The following is a partial listing of the facilities associated with the Berkeley campus:

Hydraulic Engineering Laboratory—deep wave channel; wind-wave tank, basin, and channel; wave and towing tank; model basins; sediment samplers; electronic analog-to-digital converter (HYDRA system).

Naval Architecture Laboratory—model towing tank; ship impact machine; ship structure test machine.

Sanitary Engineering Research Laboratory—treatment and reclamation of industrial and domestic wastes; apparatus for study of water pollution problems related to radioactive wastes, water resources, and air pollution.

Sea Water Conversion Laboratory—experimental unit for demineralizing sea water through solar distillation, electrodialysis, reverse osmosis, ion exchange methods.

Soil Mechanics Laboratory—strength testing with universal testing machine (4 million ton capacity); strain loading machine; triaxial compression cells; shaking table; earthquake loading machine; 8-channel oscillograph.

Structural Engineering Materials Laboratory—study behavior under load of structures and models using elastic displacement, strain measurement, moire-effect, and photo-elastic methods; control rooms provide wide range of temperature and humidity parameters.

Joint cooperation with the U. S. Bureau of Mines Marine Technology center, Tiburon, U. S. Corps of Engineers Bay Model, Sausalito, and U. S. Geological Survey Pacific Coast Marine Geology, Menlo Park round out extensive research facilities available to the Ocean Engineering student.

No one particular engineering discipline includes all the ramifications of Ocean Engineering. As a consequence, there is no Department of Ocean Engineering, and no degree in Ocean Engineering as such is granted. Ocean Engineering is a graduate option in several of the established departments in the College of Engineering. Students specializing in Ocean Engineering may obtain either a scientific or a professional degree, depending on the emphasis of the program they pursue. The degrees, **Master of Science and Doctor of Philosophy in Engineering or Engineering Science**, are granted upon completion of programs emphasizing theory, research, and design; the professional degrees, **Master of Engineering and Doctor of Engineering**, are granted upon completion of programs emphasizing economic and technical problems arising in the professional practice of engineering.

The Ocean Engineering Program within the College of Engineering includes the following departments: Civil Engineering, Materials Science and Engineering, Mechanical Engineering, and Naval Architecture. The Institute of Marine Resources sponsors research in inorganic marine resources, chiefly on the chemical and geological properties of ocean-bottom sediments in cooperation with the Ocean Engineering Program.

The Institute of Marine Resources also supports a research unit in Marine Food Science, within the administrative framework of the Department of Nutritional Sciences, College of Agricultural Sciences. Some teaching and seminars are conducted by institute personnel but no special courses are currently offered in this field. The research program involves the study of fundamental problems connected with the utilization of ocean fauna for food.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

Department of Civil Engineering

CE 201A	Physical Oceanology	F	3
CE 201B	Chemical Oceanology	W	3
CE 201C	Geological Oceanology	Sp	3

Department of Civil Engineering—*Continued*

CE 205A	Coastal Engineering	F	3
CE 205B	Coastal Engineering	W	3
CE 206A	River Hydraulics and Sedimentation	F	3
CE 206B	River Hydraulics and Sedimentation	W	3
CE 206C	River Hydraulics and Sedimentation	Sp	3
CE 207	Advanced Hydraulic Design	Sp	3
CE 208	Advanced Hydraulic-Structures Laboratory	Sp	2
CE 226	Random Vibrations of Structural Systems	F	3
CE 290J	Vibration of Ship Structures	F	3

Department of Engineering

E 298	Ocean Engineering Seminar	F, W, Sp	1

Department of Mechanical Engineering

AS 262	Theoretical Hydrodynamics	Sp	4
AS 263A, B	Viscous Fluid Flow	A–W, Sp, B–F	4–4
AS 290C	Turbulence	F	4
AS 298–5	Geophysical Fluid Mechanics		
AM 283	Wave Propagation in Elastic Media	F	4
AM 290C	Acoustic Wave Propagation	Sp	3
AM 290E	Selected Topics in Wave Propagation in Anelastic Materials	W	4
ME 164	Engineering Aero- and Hydro-Dynamics	Sp	3
ME 290N	Corrosion	W	4

Department of Materials Science and Engineering

EG 106	Applied Geophysics	Sp	3
EG 206	Electrical, Magnetic, and Gravity Methods	W	5
EG 290A	Geophysical Measurements and Instruments	W	3

Department of Naval Architecture

NA 240A, B, C	Theory of Ship Structures	A–F; B–W; C–Sp	3, 3, 3
NA 241A, B, C	Hydrodynamics of Ships	A–F; B–W; C–Sp	3, 3, 3
NA 242	Advanced Ship Design	Sp	

The instructional staff for the courses listed above consists of the following:

Department of Civil Engineering

Clough, R. W., Jr., Sc.D., Professor, Civil Engineering, Chairman of Division of Structural Engineering & Structural Mechanics
Duncan, J. M., Ph.D., Assistant Professor of Civil Engineering
Einstein, H. A., D.S.T., Professor of Hydraulic Engineering
Fischer, H. B., Ph.D., Assistant Professor of Hydraulic Engineering
Johnson, J. S., M.S., Professor of Hydraulic Engineering, Director of Hydraulic Engineering Laboratory
Lin, T. Y., M.S., Professor of Civil Engineering
Lysmer, J., Ph.D., Assistant Professor of Civil Engineering
McGauhey, P. H., M.S., Professor of Sanitary Engineering and Public Health, Director of Sanitary Engineering Research Laboratory
Mitchell, J. K., Sc.D., Associate Professor of Civil Engineering
Moffitt, F. H., M.C.E., Professor of Civil Engineering
Oswald, W. J., Ph.D., Professor of Sanitary Engineering
Pearson, E. A., Sc.D., Professor of Sanitary Engineering, Chairman, Division of Hydraulic and Sanitary Engineering
Penzien, J., Sc.D., Professor of Civil Engineering
Seed, H. B., Ph.D., Professor of Civil Engineering, Chairman, Department of Civil Engineering
Selleck, R. E., Ph.D., Associate Professor of Sanitary Engineering
Thomas, J. F., Ph.D., Professor of Sanitary Engineering

Department of Civil Engineering–*Continued*

Wiegel, R. L., M.S., Professor of Civil Engineering
Wilde, P., Ph.D., Assistant Professor of Hydraulic Engineering and Research Oceanographer, Institute of Marine Resources
Witherspoon, P. A., Ph.D., Professor of Civil Engineering

Institute of Marine Resources–Nutritional Science (College of Agriculture)

W. D. Brown, Ph.D., Associate Professor of Marine Food Science
Olcott, H.S., Ph.D., Professor of Marine Food Science

Department of Materials Science and Engineering

Borgman, L. E., Ph.D., Associate Professor of Engineering Geoscience
Fuerstenau, D. W., Sc.D., Professor of Metallurgy
Morrison, H. F., Ph.D., Assistant Professor of Geophysical Engineering
Rodgers, P., Ph.D., Assistant Professor of Geophysical Engineering
Ward, S. H., Ph.D., Professor of Geophysical Engineering

Department of Mechanical Engineering

Corcos, G. M., Ph.D., Professor of Aeronautical Sciences
Cornet, I., Ph.D., Professor of Mechanical Engineering
Holt, M., Ph.D., Professor of Aeronautical Sciences
Howe, E. D., M.S., Professor of Mechanical Engineering
Laird, A. D. K., Ph.D., Professor of Mechanical Engineering, Director of Sea Water Conversion Laboratory
Schaaf, S. A., Ph.D., Professor of Engineering Science
Sherman, F. S., Ph.D., Professor of Aeronautical Sciences

Department of Naval Architecture

Paulling, J. R., Jr., D. Eng., Associate Professor of Naval Architecture, Chairman, Department of Naval Architecture
Schade, H. A., Dr. Ing., Professor of Naval Architecture, Emeritus
Sibul, O. J., M.S., Lecturer in Naval Architecture
Wehausen, J. V., Ph.D., Professor of Engineering Science

To obtain further information, address all inquiries directly to:

A. **Ocean Engineering**

Professor P. Wilde, Chairman
Committee on Engineering in the Ocean Environment
College of Engineering
University of California
Berkeley, California 94720

B. **Marine Food Sciences**

Professor H. S. Olcott
I.M.R. Department of Nutritional Sciences
University of California
Morgan Hall
Berkeley, California 94720

THE CATHOLIC UNIVERSITY OF AMERICA
Washington, D. C.

The university offers undergraduate and graduate programs at its main campus in northeast Washington. The Institute of Ocean Science and Engineering was established at the university in 1967 to foster research and academic programs in the marine sciences. The major areas of marine related research are: underwater acoustics, properties of transducers, structure and physical properties of salt water, marine cables, instrumentation, signal processing, and fluid dynamics. Research facilities include: four tanks for underwater acoustics; one tank for underwater optics; instrumentation, fluid dynamics, soil mechanics, and physical properties of water laboratories. The university has participated in a cooperative program with three local Naval Laboratories since 1967. This program sponsors mutual use of research facilities and oceanographic ships. Computer facilities include two IBM 1130 computers (one has had extensive at-sea use on the U.S.N.S. KANE), one IBM 1620, and shared time facilities. The university is also a member of the Washington Consortium of Universities.

The following degrees are offered in ocean engineering and related fields:

1. **D. Engr. or Ph.D. in Ocean Engineering (Department of Mechanical Engineering).** Candidates for the Doctorate in Ocean Engineering must satisfactorily complete two years of full-time resident graduate study beyond the Master's degree, or its equivalent on a part-time or three-quarter time basis. Degree requirements may be summarized as follows: a major course program (a minimum of thirty-five credit hours beyond the Bachelor's degree), eighteen credit hours in a minor field (usually mathematics) or twelve credit hours in a first minor field and six credit hours in a second minor field, written comprehensive examinations in the major and first minor fields, a reading knowledge of two foreign languages, a dissertation, and an oral defense of dissertation. Doctoral programs in Ocean Engineering are tailored to meet the needs of the individual student. Candidates may specialize in Fluid or Solid Mechanics, Heat Transfer or Thermodynamics, Control System, Underwater Acoustics or Civil Engineering. All doctoral candidates in Ocean Engineering must take a minimum of nine credit hours in pure or applied oceanography, six one semester upper level graduate courses in their specialty area, and acquire appropriate at-sea experience.

2. **M.S.E. in Ocean Engineering or in Ocean Engineering (Acoustics) (Department of Mechanical Engineering).** Candidates for the degree of Master of Science in Ocean Engineering are required to satisfactorily complete one year of full-time graduate study (approximately thirty (30) credit hours including research and seminars), or its equivalent on a part-time or three-quarter time basis. A comprehensive examination in the major field plus a thesis is required. There are no foreign language requirements for the M.S.E. degree. A typical Master's program in Ocean Engineering would consist of ME 533, ME 507, CEM 541, ME 502 and one elective in pure or applied oceanography. In addition all candidates must minor in mathematics. A typical program for Ocean Engineers specializing in underwater acoustics consists of ME 507, CEM 541, CEM 562, CEM 563, an elective course in acoustics, and one in pure or applied oceanography. The minor requirements are as stated above.

3. **D. Engr. or Ph.D. in Engineering Acoustics (Department of Civil Engineering and Mechanics).** Candidates for the Doctorate in Engineering Acoustics must satisfactorily complete two years of full-time resident graduate study beyond the Master's degree, or its equivalent on a part-time or three-quarter time basis. Degree requirements may be summarized as follows: a major course program (a minimum of thirty-five credit hours beyond the Bachelor's degree), eighteen credit hours in a minor field (usually mathematics) or twelve credit hours in a first minor field and six credit hours in a second minor field, written comprehensive examinations in the major and first minor fields, a reading knowledge of two foreign languages, a dissertation, and an oral defense of the dissertation. Doctoral programs in Engineering Acoustics are tailored to meet the needs of the individual students who may specialize in either underwater, theoretical, statistical, or physical acoustics. However, the following courses are required of all doctoral candidates: CEM 532, CEM 761 and 762, and CEM 741.

4. **M.S.E. in Engineering Acoustics (Department of Civil Engineering and Mechanics).** Candidates for the degree of Master of Science in Engineering (Acoustics) are required to satisfactorily

complete one year of full-time graduate study (approximately thirty (30) credit hours including research and seminars), or its equivalent on a part-time or three-quarter time basis. A comprehensive examination in the major field plus a thesis is required. There are no foreign language requirements for the M.S.E. degree. A typical Master's program in Engineering Acoustics would consist of CEM 501, CEM 541, CEM 562, CEM 568, and two electives in the major field. In addition, all candidates must minor in mathematics.

5. **M.S.E. in Water Resources Engineering (Department of Civil Engineering and Mechanics).** Candidates for the degree of Master of Science in Engineering (Water Resources Engineering) are required to satisfactorily complete one year of full-time graduate study (approximately thirty (30) credit hours including research and seminars), or its equivalent on a part-time or three-quarter-time basis. A comprehensive examination in the major field plus a thesis is required. There are no foreign language requirements for the M.S.E. degree. A typical Master's program in Water Resources Engineering would consist of CEM 581, CEM 582, CEM 584, CEM 782, and two electives in the major field and six (6) credit hours in an appropriate minor field.

6. **B.S.M.E. (Ocean Engineering Option) (Department of Mechanical Engineering).** (This degree will be offered for the first time in 1969-70.) Undergraduate students in this program follow the same curriculum as other mechanical engineering students during the freshman and sophomore years. Required Ocean Engineering courses in the junior and senior year are ME 342, ME 344, and ME 401. The other required courses follow the M.E. curriculum. Projects related to Ocean Engineering are included in the laboratory and design courses. Fifteen semester hours of electives in the senior year may be selected from an extensive list of mechanical and ocean engineering courses at the senior and the beginning graduate level.

The following courses are offered in conjunction with the above programs:

Mechanical Engineering Department

502	Structural Mechanics	3
505, 506	Design of Mechanical Systems	2, 2
507	Physical Oceanography	3
508	Ocean Waves	3
514	Geological Oceanography	3
516	Instrumentation	3
533	Mechanics of Continua	3
535	Advanced Fluid Dynamics	3
575, 576	General Geophysics and Space Physics	2, 2
578	Desalination	2
597, 598	Mechanical Engineering Seminar	1, 1
701, 702	Advanced Design and Analysis of Mechanical Systems	2, 2
731, 732	Theoretical Hydrodynamics	3, 3
735, 736	Geophysical Fluid Mechanics	3, 3
747, 748	Physics of Fluids	3, 3

Civil Engineering and Mechanics Department

531, 532	Experimental Dynamics	3, 3
541	Advanced Dynamics	3
562	Theory of Waves	3
563	Principles of Underwater Sound	2
564	Underwater Sound Propagation	2
568	Electromechanical Circuits and Transducers	2
741, 742	Vibrations of Elastic Solids	3
744	Nonlinear Vibrations	3
761, 762	Theoretical Acoustics	3
772	Physical Acoustics	3
763, 764	Special Topics in Advanced Acoustics	2, 2
525	Waterways and Harbor Engineering	3
581	Hydrology	3

Civil Engineering and Mechanics Department—*Continued*

582	Hydraulics of Open Channels	3
583	Water Resources Engineering Economics	3
584	Water Supply and Pollution Control Engineering	3
585, 586	Water Resources Planning	3, 3
587	Current Problems in Water Resources	3
588	Public Water Policies and Organizations	3
682	Objectives and Applications of Water Resources Development	3
725	Waterways and Dam Engineering	3
782	Water Resources Systems Analysis	3
783, 784	Water Quality Management	3
788	Planning for Hydroelectric Power Development	3

Odd-numbered courses are offered in the Fall Semester and even-numbered courses in the Spring.

The instructional staff for the courses listed above consists of the following:

Department of Mechanical Engineering

Andrews, Frank A., Ph.D., Chairman and Professor of Acoustics
Blomquist, Donald S., M.S., Assistant Professor in Mechanical Engineering-Instrumentation
Casarella, Mario J., Ph.D., Associate Professor of Fluid Mechanics
Curran, Henry M., Ph.D., Associate Professor of Mechanical Engineering
Gilheany, John J., Ph.D., Associate Professor of Ocean Engineering
Heller, S. R., Jr., Sc.D., Professor of Ocean Engineering
Jackson, Francis J., Ph.D., Adjunct Professor of Acoustics
Laura, Patricio A., Ph.D., Associate Professor of Mechanical Engineering
Schneider, Erick, M.S., Lecturer in Oceanography
Schule, John J., B.A., Lecturer in Oceanography

Department of Civil Engineering and Mechanics

Baltrukonis, John H., M.C.E., Chairman and Professor of Mechanics
Dea, Stanley, Ph.D., Lecturer in Water Resources
Greenspan, Martin, B.S., Adjunct Professor of Acoustics
Hanish, Samuel, M.S., Lecturer
Hudimac, Albert A., Ph.D., Associate Professor of Acoustics
Macedo, Pedro B., Ph.D., Associate Professor of Acoustics
Magrab, Edward B., Ph.D., Associate Professor of Mechanics
Martin, Edward, Ph.D., Lecturer in Water Resources
McDaniel, William, M.A., Associate Professor of Planning
Pappas, Dean, M.S.E., Lecturer in Water Resources
Parsons, Donald, M.S.C.E., Lecturer in Hydrology
Urick, Robert, M.S., Lecturer in Acoustics
Witzig, Bernard, C.E., Lecturer in Water Resources
Young, G. Kenneth, Ph.D., Lecturer in Water Resources

To obtain further information, address all inquiries directly to:

Dr. John J. Gilheany
Institute of Ocean Science and Engineering
Catholic University of America
Washington, D. C.

UNIVERSITY OF DELAWARE
Newark, Delaware

Ocean Engineering courses are offered both at the main campus in Newark and the Marine Laboratory's field station at Lewes, Delaware. On campus laboratory facilities are located primarily within the departments of Civil and Mechanical and Aerospace Engineering. The fluid mechanics laboratory contains a free surface hydrodynamic tank with flows to 4000 gpm., a subsonic wind tunnel (140 fps), a ripple-tow tank with 4 ft. x 6 ft. test section, a 120 ft. long x 5 ft. x 8 ft. flume, a rotating flow table and a small wave tank. High speed cameras and hydrogen bubble generators used for flow visualization are among the specialized equipment available.

The environmental engineering laboratories are equipped for chemical and biological analysis of water. Specialized equipment includes stability indicator, turbidimeter, BOD apparatus, Kjeldahl N apparatus, spectrophotometer, polarograph, rotary viscometer, Warburg respirator, and a D.O. probe accurate to one part per billion of dissolved oxygen.

Well equipped soil mechanics, metallurgical, and structural laboratories are also available for marine-oriented research. Field research and instruction in coastal and oceanographic engineering are conducted at the Lewes field station using classrooms, laboratories, and vessels located there.

The University offers the following degrees:

1. **Bachelor of Civil Engineering–Specialization in Ocean Engineering (Department of Civil Engineering).** All students are required to complete the basic civil engineering curriculum requiring (130) semester hours of course credit. This includes (112) hours of required course work and allows (18) hours of technical electives which may be devoted to marine-related courses or special projects. Similar B.S. degree programs in Chemical Engineering, Electrical Engineering and Mechanical and Aerospace Engineering.
2. **Master of Applied Science in Ocean Engineering.** This program requires that a student complete (30) credit hours of graduate study beyond the bachelor's degree of which (24) are in course work plus (6) hours of thesis. Considerable flexibility is available to permit a student to formulate a program suited to his specific interests.
3. **Ph.D. of Applied Science in Ocean Engineering.** Essentially 72 semester credits beyond the bachelor's degree are required including approximately (24) credits in the areas of mathematics, physical and engineering science, and (24) credits in thesis research. A broad range of programs can be arranged to fit the student's particular research interests.

Ocean engineering is an interdisciplinary program sponsored on an interdepartmental basis by the College of Engineering. At present most marine-related courses are offered by the Department of Civil Engineering but with other departments (i.e., Chemical, Electrical, and Mechanical and Aerospace) prepared to assist students in formulating programs in their area of specialization, and to provide appropriate special problem studies.

The courses specifically related to an ocean engineering program are listed below. Other courses not listed, but available to complete an ocean engineering program, are offered in the areas of oceanography, marine biology, mathematics, statistics, operations research, structural engineering, water resources engineering, fluid mechanics, hydraulics, electrical engineering, transportation engineering, soil mechanics, mechanical engineering, metallurgy and materials engineering.

CE 665	Ocean Engineering Seminar	F, Sp	1
CE 666	Engineering in a Coastal Environment	Su	3
CE 671	Ocean Engineering I	F	3
CE 672	Ocean Engineering II	Sp	3
CE 837	Mechanics of Free Surface Flow	F*	3
CE 839	Applied Hydraulics	Sp*	3
CE 866	Special Problems		1–6
CE 871	Marine Structures I (Floating)	F	3
CE 872	Marine Structures II (Fixed)	Sp	3

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*Offered in alternate years.

CE 873*	Marine Transportation Systems	Sp	3
CE 874*	Geophysical Fluid Mechanics		3
G 220	Meteorology	Sp	3
GEO 631	Marine Geology		3
GEO 637	Geology of Recent Sedimentary Environments		3
MAE 622	Introduction to Stability and Control		3
MAE 633	Hydromechanics		3
MAE 833	Fluid Mechanic Stability		3
MET 611	Corrosion and Corrosion Control	Sp	3

The University also offers undergraduate and graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Civil Engineering

Boyer, Don L., Ph.D., Assistant Professor of Civil and Mechanical and Aerospace Engineering

Gaither, William S., Ph.D., Associate Professor of Civil Engineering and Ocean Engineering Program Coordinator

Jordaan, Jan M., Sc.D., Associate Professor of Civil Engineering

Department of Mechanical and Aerospace Engineering

Seidel, Barry S., Sc.D., Associate Professor of Mechanical and Aerospace Engineering

To obtain further information, address all inquiries directly to:

Dr. W. S. Gaither
College of Engineering
University of Delaware
Newark, Delaware 19711

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*Available upon sufficient student demand.

FLORIDA ATLANTIC UNIVERSITY
Boca Raton, Florida

Florida Atlantic University offers ocean engineering and marine science courses at its main campus in Boca Raton, Florida. Florida Atlantic University is an upper division university (junior and senior years plus graduate work) which includes a College of Science and a separate Department of Ocean Engineering. It is a part of the State of Florida University system. Students entering FAU must have successfully completed two years at a junior college or the equivalent at a four year institution and meet the prerequisites of the department they desire to enter.

The Department of Ocean Engineering has laboratories for Electrical, Mechanical and Materials Engineering; Fluids and Acoustics instruction. Small boats are available for ocean engineering instruction and work at sea. Large vessels, when needed, will be chartered or obtained through the Florida Institute of Oceanography.

A Cooperative Work-Study program is available for students who maintain a 2.5 (out of 4.0) average which enables them to spend alternating 6 month periods on campus and on-the-job with participating ocean engineering companies and government laboratories. Students can enter the Cooperative program in September or March of each calendar year.

The University offers the degree of **B.S. in Engineering.*** All students are required to follow a curriculum covering the courses listed below plus a business course and one non-technical elective. Students entering the program must have completed two years of pre-engineering, university-parallel transfer courses including Mathematics through Calculus, one year each of Chemistry, Physics (with Calculus), English Composition, Humanities, Social Science, plus electives to make a total of at least 60 semester or 90 quarter hours. Practical work is stressed in the "Ocean Engineering Laboratory" and "Summer Practical Work and Independent Study Courses."

The Department of Ocean Engineering provides a comprehensive, practical curriculum in science and engineering which will prepare the student to perform engineering tasks in the ocean. The curriculum prepares the student for graduate study in ocean engineering and for professional positions in industry, government and science.

The Ocean Engineering program covers integrated work units encompassing basic engineering sciences and mathematics; study of the ocean environment and its relationship to other sciences and engineering; instrumentation and processing of ocean engineering data; and their application to engineering problems connected with working in, on, or exploiting the resources of the oceans.

Emphasis is placed on the solution of problems related to working in the ocean in areas such as underwater acoustics, fluid mechanics, structures, electronics, instrumentation, and materials. A summer quarter is devoted to practical work in ocean engineering. The following courses are offered in conjunction with the University's degree program (the credits shown are quarter credits):

OCEN 404	Oceanography I	3
OCEN 414	Elements of Electrical Engineering I	4
OCEN 425	Statics	4
OCEN 437	Thermodynamics I	3
OCEN 405	Oceanography II	3
OCEN 415	Elements of Electrical Engineering II	4
OCEN 426	Dynamics	4
OCEN 438	Thermodynamics II	3
OCEN 406	Oceanography III	3
OCEN 407	Ocean Engineering Laboratory	2
OCEN 416	Elements of Electrical Engineering III	4
OCEN 429	Fluid Mechanics I	3
OCEN 434	Strength of Materials I	3
OCEN 450	Practical Work and Independent Study	3
OCEN 401	Engineering Materials I	4

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*(An M.S. in Engineering (Ocean Engineering) is proposed for the 1969-70 academic year.)

OCEN 423	Instrumentation	3
OCEN 420	Acoustics	3
OCEN 430	Fluid Mechanics II	3
OCEN 435	Strength of Materials II	3
OCEN 402	Engineering Materials II	4
OCEN 421	Underwater Acoustics I	3
OCEN 431	Fluid Mechanics III	3
OCEN 440	Heat Transfer	3
OCEN 412	Shock & Vibration	3
OCEN 422	Underwater Acoustics II	3
OCEN 432	Underwater Structures	3
OCEN 460	Ocean Engineering Seminar	1

Supporting Science Courses

MATH 470	Differential Equations
MATH 427	Statistical Methods
CHEM 307	Introduction to Physical Chemistry
BIOL 435	Marine Biology

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Ocean Engineering

Stephan, Charles R., B.S., Chairman and Professor of Ocean Engineering
McAllister, Raymond F., Ph.D., Professor of Oceanography
Tessin, William, Ph.D., Professor of Ocean Engineering
Davidson, James B., M.S., Associate Professor of Ocean Engineering
Mudge, William A., Ph.D., Visiting Professor
Brannock, Robert N., Ph.D., Associate Professor of Ocean Engineering
Villanueva, José, Ph.D., Associate Professor of Ocean Engineering
Graham, Peter, Ph.D., Assistant Professor of Ocean Engineering
Case, Robert O., Ph.D., Assistant Professor of Ocean Engineering
Manring, James E., M.E., Assistant Professor of Ocean Engineering
Monroe, Frederick F., B.A., Assistant Professor
Lee, Thomas N., M.S., Visiting Assistant Professor of Oceanography
Hartt, William H., Ph.D., Instructor of Ocean Engineering

To obtain further information, address all inquiries directly to:

Professor Charles R. Stephan
Chairman, Department of Ocean Engineering
Florida Atlantic University
Boca Raton, Florida 33432

UNIVERSITY OF FLORIDA
Gainesville, Florida

The Coastal and Oceanographic Engineering Department facilities include a laboratory equipped with a covered wave tank for air-sea interaction experiments, a second wave tank for general experiments, a wave basin for model studies of sections of coastlines, and various other laboratory facilities. Equipment required for field studies, including two small survey vessels, is available within the department.

The University offers the degrees of **M.S. and Ph.D. in Civil Engineering** with an emphasis in Coastal and Oceanographic Engineering.*

The following courses are offered in conjunction with these programs:

Undergraduate Course

400	Introduction to Coastal and Oceanographic Engineering	3

Graduate Courses—Department of Coastal and Oceanographic Engineering

610	Ocean Waves 1: Linear Theory	4
611	Ocean Waves 2: Nonlinear Theory	4
612	Ocean Wave Spectra	4
613	Long Waves and Tides	4
620	Coastal Structures 1: Theory	4
621	Coastal Structures 2: Applications	4
630	Littoral Processes	4
631	Simulation Techniques	4
632	Selected Field and LaboratoryProblems	3–8
640	Physical Oceanography	4
641	Air-Sea Interaction 1: Microscale	4
642	Air-Sea Interaction 2: Macroscale	4
643	Advanced Topics in Coastal and Oceanographic Engineering	1–6
699	Master's Research	0–9 Max. 24

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Coastal and Oceanographic Engineering

Dean, Robert G., Sc.D., Professor and Chairman, Department of Coastal and Oceanographic Engineering

Jen, Yuan, Ph.D., Assistant Professor of Coastal and Oceanographic Engineering

Partheniades, Emmanuel, Ph.D., Associate Professor of Coastal and Oceanographic Engineering

Shemdin, Omar H., Ph.D., Assistant Professor of Coastal and Oceanographic Engineering

To obtain further information, address all inquiries directly to:

Department of Coastal and Oceanographic Engineering

Dr. R. G. Dean
Department of Coastal and Oceanographic Engineering
University of Florida
Gainesville, Florida 32601

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*(An M.S. in Coastal and Oceanographic Engineering is proposed.)

GULF COAST TECHNICAL INSTITUTE
MISSISSIPPI STATE UNIVERSITY
Gulfport, Mississippi

The Institute has well-equipped design and electronic laboratories and computing facilities.

All curriculums at the Gulf Coast Technical Institute lead to the **Bachelor of Engineering Technology** degree awarded by Mississippi State University.

The Marine Science courses are offered as electives to the curriculums of Construction Engineering Technology and Electronic Engineering Technology as a Marine option.

Marine Engineering Technology

MAT 2004	Shipbuilding Technology I	3
MAT 2103	Marine Engineering Technology I	3
MAT 2603	Naval Architecture Technology I	3
MAT 3023	Shipbuilding Technology II	3
MAT 3114	Marine Engineering Technology II	4
MAT 3123	Marine Engineering Technology III	3
MAT 3404	Shipboard Ventilation	4
MAT 3614	Naval Architecture Technology II	4
MAT 3623	Naval Architecture Technology III	3
GET 2303	Applied Thermodynamics	3
GET 2403	Metals Technology	3
GET 3313	Applied Fluid Mechanics	3
GET 3323	Applied Dynamics	3

Marine Science

GET 2403	Oceanography I	3
GET 2503	Oceanography II	3
GET 3023	Marine Structures	3
GET 3003	Introduction to Underwater Acoustics	3

The instructional staff for the courses listed above consists of the following:

Kennedy, Charles E., M.S., Assistant Professor of Mechanical Engineering Technology

Leavitt, Clyde M., B.S., Adjunct Associate Professor of Marine Engineering Technology

To obtain further information, address all inquiries directly to:

Director
Gulf Coast Technical Institute
Box 458
Gulfport, Mississippi 39501

UNIVERSITY OF HAWAII
Honolulu, Hawaii

The major research facility is the Look Laboratory of Oceanographic Engineering. It is the first structure of the Kewalo Oceanographic Research Center, and supports research activity that has direct bearing on many ocean-related problems occurring throughout the state of Hawaii. Facilities are being doubled in capacity and capability. Construction is underway, and will be completed in 1969, ready for operation by summer or fall of 1969.

The **Master of Science in Ocean Engineering** is an interdepartmental graduate program contributed to by the Departments of Oceanography, Civil Engineering, Electrical Engineering, and Mechanical Engineering. Plan A (thesis program) is recommended but Plan B (non-thesis) may be permitted. Choice of plan must be made before 14 credits of graduate work applicable to the degree have been completed. A foreign language is not required.

Plan A requires a minimum total of 30 credit hours, including 24 credit hours of course work and 8 credit hours of thesis research. Six credit hours of course work may be taken outside the College of Engineering and the Department of Oceanography. At least 8 credits must be in courses numbered 600–799.

Plan B requires 30 credits of course work. At least 6 credit hours shall be taken outside the College of Engineering and the Department of Oceanography. At least 8 credits must be in engineering courses. Two graduate seminars in engineering or oceanography are required. A minimum of 18 credits must be in courses numbered 600–799.

The following courses are required of all students in ocean engineering:

O.E. 603	Ocean Engineering Environment	F	3
O.E. 697–698	Ocean Engineering Seminar	Sp	1–1
Ocean 620	Physical Oceanography	F	3
C.E. 641	Ocean Engineering	F	3

Six credits of approved courses may be selected from physics, mathematics, chemistry, or geosciences. Additional courses normally will be selected from the following list:

Ocean Engineering		
605	Naval Architecture in Ocean Engineering	3
606	Dynamics of Offshore Floating Structures	3
608	Submarine Vehicle Naval Architecture	3
Civil Engineering		
621	Advanced Fluid Mechanics I	3
622	Advanced Fluid Mechanics II	3
635	Environmental and Sanitary Engineering Chemistry	4
636	Environmental and Sanitary Engineering Microbiology	4
642	Coastal and Harbor Engineering	3
644	Ocean Hydrodynamics Laboratory	2
655	Advanced Soil Mechanics	3
671	Theory of Elasticity	3
674	Stability of Structures	3
675	Theory of Vibrations	3
676	Structural Dynamics	3
678	Theory of Plates	3
679	Theory of Thin Shells	3
681	Advanced Indeterminate Structures	3
682	Numerical Methods of Stress Analysis	3
683	Advanced Reinforced Concrete Design	3
Electrical Engineering		
623	Advanced Electronic Instrumentation	3
651	Advanced Feedback Control Systems	3
652	Optimization Techniques in Control Systems	3

Electrical Engineering–*Continued*		
655	Sampled-Data Control Systems	3
661	Theory of Digital Machines	3
671–672	Electromagnetic Theory and Applications	3–3
Mechanical Engineering		
611	Classical Thermodynamics	3
621–622	Conduction Heat Transfer	3–3
631	Mechanical Properties of Materials	3
636	Materials for the Ocean Environment	2
Oceanography		
622	Geological Oceanography	3
623	Chemical Oceanography	2
632	Littoral Geological Processes	3
640	Advanced Physical Oceanography	3
642	Recent Marine Sediments	3
660	Ocean Wave Theory	3
661	Tides	3

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Bretschneider, C. L., Ph.D. (Chairman)–Civil Engineering, Physical Oceanography
Adams, W. M., Ph.D.–Geophysics, Geophysical Engineering
Burbank, N., Sc.D.–Environmental Engineering
Grace, R., Ph.D.–Civil Engineering
Larsen-Badse, J., Ph.D.–Materials Science
Williams, J. A., Ph.D.–Civil and Ocean Engineering, Hydrodynamics
St. Denis, M., Dr.Sc.–Naval Architecture
Allmendinger, E.,–Naval Architecture

To obtain further information, address all inquiries directly to:

Dr. Charles L. Bretschneider
Department of Oceanography
University of Hawaii
Honolulu, Hawaii 96822

UNIVERSITY OF HOUSTON
Houston, Texas

Marine sciences are taught in the Cullen College of Engineering and in the College of Arts and Sciences. The University has a SDS Sigma 7 digital computing system available to qualified students, and the Cullen College of Engineering is currently adding a large scale modern hybrid computing facility for engineering research. In addition, the Engineering School has recently acquired two large analog computing facilites from the General Electric Company and a large scale digital computer ideal for instructional purposes from NASA. Sea going vessels are available to all students through ocean related programs of the Geology and Biology Departments, as well as access to offshore drilling platforms of the oil industry. The University and Texas A&M University are developing a cooperative program in ocean engineering which will make available a large oceanographic research vessel and additional shore-based facilities. The University is a member of the Gulf Universities Research Corporation, which is described in the Consortia section of this publication.

The Cullen College of Engineering has recently moved into a new engineering building with adequate classroom and laboratory facilities for instruction in oceanography, ocean engineering, and related fields. In the College of Arts and Sciences, the Department of Geology has about 26,500 square feet of space, Biophysics about 9000 square feet, and Biology about 50,000 square feet. Modern research facilities, including wet labs and cold storage, are available on the main campus, and supplementary facilities are being developed in the Galveston Bay area.

The **Master of Science** and **Doctor of Philosophy Degrees with Ocean Engineering options are granted in Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, and Petroleum Engineering.** In addition, **Master of Science (Undifferentiated)** and **Doctor of Philosophy (Undifferentiated)** Degrees may be granted in interdisciplinary ocean engineering programs and in the College of Arts & Sciences.

The requirements for these degrees are as follows:

1. **Master of Science**

Twenty-four or more semester hours of academic work are required in addition to a thesis, which counts for a minimum of six semester hours. At least 12 semester hours, excluding the thesis, must be completed within the major field, and, at the discretion of the department chairman, 18 semester hours may be required in the major field. No student may register for credit for more than 13 semester hours, exclusive of thesis and seminar, in any one semester.

The student must satisfactorily defend his thesis, prior to its acceptance, before a committee appointed by the department chairman and approved by the Dean of the Cullen College of Engineering.

Before a student has completed 12 semester hours of graduate study, he may be required to take a written examination covering the fundamentals of engineering and mathematics. If he fails to perform satisfactorily in any given area, he will be required to take additional work to remove the indicated deficiency.

2. **Doctor of Philosophy**

Requirements:

a. A minimum of 52 semester hours of approved graduate study beyond the master's degree, to include the following:
   (1) Major courses, 7-10 semester hours
   (2) Electives in related fields, 12-15 semester hours
   (3) Research and Dissertation, 30 semester hours
b. A minimum of two semesters and two summer sessions of residence in full-time graduate study.
c. Successful completion of written qualifying examinations.
d. Technical reading examination or approved academic training (6 semester hours) in a modern foreign language (excluding a student's native language) pertinent to the individual research program.

e. Original research work, leading to a publishable contribution to engineering science, must be carried out under the direction of a faculty member and, upon completion, the candidate must defend the written dissertation in a final oral examination.

f. Admission to candidacy: After completing the qualifying examination, the foreign language requirement, and 30 semester hours of the program, and with the approval of the department, the student will be admitted to candidacy.

The Cullen College of Engineering of the University of Houston has undergraduate programs in chemical, civil, electrical, industrial, and mechanical engineering. In addition, these departments have graduate course offerings in many areas of special interest to ocean engineering. Some of the most significant of these courses in the Chemical Engineering Department are:

ChE 530	Corrosion
ChE 631:632	Mathematical Methods in Chemical Engineering
ChE 664	Flows Through Porous Media
ChE 731	Advanced Fluid Mechanics I
ChE 733	Gas Dynamics II
ChE 735	Advanced Fluid Mechanics II
ChE 736	Advanced Fluid Mechanics III

The Department of Electrical Engineering also offers supporting course offerings for ocean engineering. Some of the most significant of the electrical engineering courses which are applicable to ocean engineering development include:

EE 575	Control Engineering
EE 576	Communication Theory
EE 617:618	Propagation and Microwave Laboratory
EE 630	Foundations of Analysis
EE 631	Information Theory
EE 633	Control System Design
EE 637	Advanced Electromagnetic Waves
EE 663	Environmental Biotechnology
EE 664	Systems Biotechnology
EE 669	Ocean Engineering Instrumentation
EE 690	Engineering Analysis I
EE 691	Engineering Analysis II
EE 737	Statistical Wave Propagation
EE 739	Advanced Topics In Electromagnetic Theory

These courses are in addition to programs in electronics, control engineering, information theory, and hybrid computer applications.

The Mechanical Engineering Department at the University of Houston offers courses in fluid mechanics, hydrodynamics, and vibration analysis—all of which are pertinent to an ocean engineering program. Some of the most significant courses currently being offered in Mechanical Engineering include:

ME 565	General Acoustics
ME 571	Vibration Analysis
ME 638	Aerothermodynamics
ME 660	Introduction to Advanced Dynamics
ME 661	Advanced Vibration Analysis
ME 662	Advanced Dynamics
ME 665	Physical Acoustics
ME 666	Engineering Acoustics
ME 690	Engineering Analysis I
ME 691	Engineering Analysis II
ME 731	Advanced Fluid Mechanics I—Laminar Flow
ME 732	Hydrodynamics I
ME 733	Gas Dynamics II

ME 734	Hydrodynamics II
ME 735	Advanced Fluid Mechanics II–Turbulent Flow
ME 736	Advanced Fluid Mechanics III–Boundary Layer Flow
ME 739	Hydrodynamics of Waves
ME 760	Nonlinear Analysis

The Mechanical Engineering Department has a special emphasis on underwater acoustics, including underwater horn design and propagation characteristics.

Although ocean engineering is taught as an interdisciplinary program at the University of Houston, the primary responsibility for curricula development rests with the Department of Civil Engineering. The ocean engineering effort is significantly aided by programs in environmental engineering, structures, and soil mechanics. Principal courses which pertain to ocean engineering in the Civil Engineering Department include:

CE 461	Environmental Engineering Practices	3
CE 533	Evaluation of Water Quality in Natural Waters	3
CE 573	Ocean Waves	3
CE 582	Air Monitoring and Measurements	
CE 594	Water Monitoring and Measurements	
CE 630	Hydromechanics	3
CE 631	Hydraulics of Open Channel Flow	3
CE 637	Advanced Structural Analysis	
CE 639	Soil Dynamics	
CE 666	Oceanographic Aspects of Coastal Engineering	3
CE 667	Waterways, Ports, and Harbors	
CE 668	Environmental Factors in Ocean Engineering	3
CE 669	Ocean Engineering Instrumentation	3
CE 681	Microclimatology	3
CE 691	Advanced Water and Wastewater Treatment	
CE 731	Advanced Hydrodynamics	
CE 734	Hydraulic Transients	3
CE 735	Hydrodynamics of Waves	3
CE 736	Nonlinear Ocean Waves	
CE 737	Matrix Analysis of Structures	3
CE 738	Dynamics of Structures	3

Related courses are also offered in the following departments:

Biology Department

BIO 426A; 426B	Ecological Methods
BIO 431	Phytopathology
BIO 436	Ecology
BIO 443	Comparative Animal Physiology
BIO 444A	Marine Biology
BIO 633	Marine Plants
BIO 633A	Physiology of Marine Bacteria
BIO 683A	Physiology of Marine Animals

Biophysics Department

BPH 432:433	General Biophysics
BPH 421	Biophysical Instrumentation
BPH 633	Molecular Biophysics

Geology Department

GEO 380	Geology for Engineers
GEO 431	Earth Physics
GEO 438	Physical Oceanography
GEO 490	Earth Science Studies
GEO 631	Marine Geology

Geology Department–*Continued*	
GEO 633	Nearshore Processes & Problems
GEO 667	Geochemistry I
GEO 668	Geochemistry II
GEO 669	Organic Geochemistry
GEO 680	Advanced Sedimentation
GEO 690	Paleontological Taxonomy
GEO 691	Micropaleontology
GEO 692	Biostratigraphy
GEO 694	Paleoecology
GEO 696	Stratigraphic Analysis
College of Law	
Law 521 W	International Commercial Law
Law 521 Y	Public International Law
Physics	
PHY 330	Physical Meteorology
PHY 430	Dynamical Meteorology
Geography	
GGY 131	Elements of Physical Geography
GGY 215	Field Mapping
GGY 333	Climates

The instructional staff for the courses listed above consists of the following:

Cullen College of Engineering

Blumberg, Randolph, Ph.D., Associate Professor of Ocean Engineering
Castellanos, Leo John, M.E., Professor of Mechanical Engineering
Dalton, Charles, Ph.D., Associate Professor of Mechanical Engineering
Dukler, A. E., Ph.D., Professor of Chemical Engineering
Finch, Robert D., Ph.D., Associate Professor of Mechanical Engineering
Ghazzaly, Osman I., Ph.D., Assistant Professor of Civil Engineering
Graff, William J., Ph.D., Professor of Civil Engineering
Hayre, Harbhajan S., D.Sc., Professor of Electrical Engineering
Hwang, Neddy H.C., Ph.D., Associate Professor of Civil Engineering
Muster, Douglas F., Ph.D., Professor of Mechanical Engineering
Myrick, H. Nugent, Sc.D., Associate Professor of Civil Engineering
Overton, Harold L., M.S., Associate Professor of Petroleum Engineering
Schneider, William P., S.M., Professor of Electrical Engineering
White, Ardis H., Ph.D., Professor of Civil Engineering

Biology Department

Fair, Jerrell F., Ph.D., Assistant Professor of Biology
Lawrence, Addison L., Ph.D., Associate Professor of Biology
Mann, James E., Ph.D., Assistant Professor of Biology
Wright, Howard O., Ph.D., Assistant Professor of Biology

Biophysics Department

Bartel, Allen H., Ph.D., Professor of Biology and Biophysics

Geography Department

Hyer, June, Ph.D., Professor of Geography

Geology

Bishop, Margaret S., Ph.D., Professor of Geology
Lohse, E. Alan, Ph.D., Associate Professor of Geology
Maddocks, Rosalie, Ph.D., Assistant Professor of Geology
Sadlick, Walter, Ph.D., Associate Professor of Geology
Van Siclen, DeWitt C., Ph.D., Professor of Geology

College of Law
Mixon, John, L.L.M., Professor of Law
Physics Department
Graves, Leon, S.M., Associate Professor of Physics

To obtain further information, address all inquiries directly to:

Dr. Randolph Blumberg, Chairman
Ocean Engineering Committee
Cullen College of Engineering
University of Houston
Houston, Texas 77004

Dr. E. Alan Lohse
Geology Department
College of Arts and Science
University of Houston
Houston, Texas 77004

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Cambridge, Massachusetts

Over the past decade the Massachusetts Institute of Technology has developed a wide range of unique facilities for applied research related to the utilization of the oceans and the ocean resources. In addition to the vast facilities in basic and engineering research in the various departments of the Institute and the unique facilities of the Instrumentation Laboratory and the Information Processing Services Center as well as those of the Woods Hole Oceanographic Institution (available to MIT through the joint MIT/WHOI Program), the following special marine-oriented facilities are available: variable pressure water tunnel, ship model towing tank, acoustics and vibration laboratory, MIT ship structures laboratory, research vessel SHROCK, coastal engineering model basin, wave channel, sedimentation flume, reservoir stratification model, pressure testing facility, and a stroboscopic light laboratory.

The following degrees are offered in the Department of Naval Architecture and Marine Engineering:

1. **B.S. in Naval Architecture and Marine Engineering**

All undergraduate students are required to take 68 units in the academic area of Humanities and Social Science. In addition, 12 units of Chemistry subject matter, 24 units of Physics and 24 units of Calculus are required. Each student must fulfill the requirement of satisfactorily completing 12 units of credit in a laboratory course. All of the foregoing requirements involve subjects outside the Department of Naval Architecutre and Marine Engineering. The Departmental requirements include the following mandatory subjects:

2.01	Mechanics of Solids	12
2.02	Introduction to System Dynamics	12
2.201	Fluid Mechanics	12
2.403	Thermodynamics	12
3.141	Science of Materials	12
13.00T	Introduction to Marine Hydrodynamics	12
13.20	Energy Conversion Systems and Components	12
13.30T	Ship Structural Analysis and Design	12
13.40	Introductory Ship Design	9
18.034	Differential Equations	12
18.05	Advanced Calculus for Engineers	12
	Thesis	9

The total units required include

Institute Requirements	140
Mandatory Departmental Subjects	153
Unrestricted Electives	67
	360

2. **M.S. in Shipping and Shipbuilding Management**
3. **M.S. in Marine Engineering**
4. **M.S. in Naval Architecture**
5. **M.S. in Naval Engineering**
6. **M.S. in Ocean Engineering**

A program of graduate study in the Department is almost entirely under the control of the student, with assistance in his planning by his Graduate Registration Officer. An acceptable graduate program of 72 credit units plus an acceptable thesis leads to the degree of Master of Science in Naval Architecture and Marine Engineering or in Ocean Engineering; this program can usually be completed in one academic year if it is based on an undergraduate curriculum equivalent in scope and emphasis to that available in the Department.

Deficiencies in undergraduate preparation must be removed prior to the award of any of the degrees implying specification. This may be accomplished concurrently with graduate work if the deficiencies are not extensive. Undergraduate subjects so required are not acceptable to the Department in partial fulfillment of the advanced degree requirements. Somewhat less broad undergraduate work is appropriate for candidates for the degree of Master of Science without specification, if accompanied by correspondingly increased competence in areas pertinent to the proposed graduate program.

The program of studies for an advanced degree must be acceptable to the Departmental Committee on Graduate Students. Unless special approval is given by this Committee, candidates for any graduate degree are expected to include in their programs at least one term of advanced mathematics beyond the requirements of the Department's undergraduate curriculum. The program for an M.S. degree must include a minimum of 72 subject units plus a thesis acceptable to the Department. A minimum of 48 of the 72 units must be "A" subjects.

To be recommended for a Master's degree, a student must have, in addition to a clear record in a program of graduate study and research as defined above, a scholastic standing of a distinctly high grade. The residence requirement for the Master's degree is one full academic term.

7. **Nav. E.–Naval Engineer**
8. **Nav. A.–Naval Architect**
9. **Mar. Mech. E.–Marine Mechanical Engineer**
10. **Ocean E.–Ocean Engineer**

The objective of a program leading to an Engineer degree is a more advanced level and a broader range of competence in engineering and science than that required for the Master's degree, but with less emphasis on creative research than that characterizing a doctoral program. In general terms, the Master's degree requires a minimum of one academic year and the Engineer degree two academic years beyond a baccalaureate in the same field.

The requirements for an Engineer degree is the satisfactory completion of a program of advanced study and research approved by the Department. The minimum program consists of at least 162 subject units and the completion of an acceptable thesis. A department may accept a Master's thesis of superior quality for the Engineer degree.

A graduate of the Institute who enrolls for an Engineer degree in the same department in which he received his Bachelor's degree, or others with equivalent preparation, may complete the requirements for that degree in four academic terms; a student with less direct or extensive preparation will require a longer time.

The caliber and scope of the Master's and Engineer theses are, in general, such as to require the equivalent of the full time of a student for at least a half of a term. Many theses may require a somewhat longer time. Every degree candidate working on a thesis is expected to register for the appropriate number of hours per week devoted to thesis in all periods during which his thesis research is actually in progress.

A program for an Engineer degree ordinarily includes two subjects in the area of economics, industrial management, or political science, and at least 12 units of comprehensive design, such as DESIGN OF A WATERBORNE VEHICLE (13.42), or the equivalent. A single thesis will generally be acceptable for both the Master of Science and Engineer degrees, provided it is appropriate to the specifications of both degrees.

The residence requirement for the Engineer degree is two full academic terms.

11. **Sc.D.–Doctor of Science**
12. **Ph.D.–Doctor of Philosophy**

To obtain the degree of Doctor of Science or Doctor of Philosophy usually requires a minimum of three years of graduate work if the thesis can be completed in one year. Specialization in any aspect of naval architecture, marine engineering, or ocean engineering is appropriate.

The three basic requirements for a doctorate are:

1. Completion of a program of advanced study, including a general examination.
2. Demonstration of proficiency in modern foreign languages, as explained in detail below.
3. Completion and oral defense of a thesis on original research.

The program of advanced study and research may be selected in any field approved by the Department. The thesis is in this same field. The program often comprises subject areas reaching into several departments. If the field requires substantial participation by two or more departments, an interdepartmental faculty committee may be appointed by the Dean of the Graduate School to advise with a Graduate Registration Officer in the administration of the student's program.

Each doctoral candidate will have a general examination in his field at such time and in such manner as his departmental or interdepartmental committee approves. This examination consists of both oral and written parts.

Each candidate for a doctorate must demonstrate to the Department of Modern Languages and Linguistics:

Either

1. Intermediate competence in speaking and reading one modern foreign language

or

2. Ability to read and translate the scientific literature of his field of specialization from two modern foreign languages into English.

The caliber and scope of the doctoral thesis are such as to require, in all but very exceptional cases, the equivalent of at least one full-time academic year of research. Many doctoral researches require a substantially longer time. Each doctoral candidate is expected to register for the appropriate number of units of thesis in all periods during which work pertaining thereto is actually in progress.

The residence requirement for a doctorate is two full academic years.

The following courses are offered in conjunction with the above programs:

Department of Naval Architecture and Marine Engineering

13.00T	Introduction to Marine Hydrodynamics	Sp	12
13.01	Applied Hydrostatics	Su	10
13.02T	Marine Hydrodynamics	F, Sp	12
13.03T	Advanced Hydromechanics of Ship Design (A)	Sp	9
13.04T	Two-Dimensional Hydrofoil Theory (A)	F	12
13.05T	Three-Dimensional Hydrofoil Theory (A)	Sp	12
13.07	Free Surface Hydrodynamics (A)	F	9
13.08T	Stability and Motion Control of Ocean Vehicles (A)	F	9
13.10T	Introduction to Structural Mechanics	F	9
13.11T	Theory of Plates and Shells (A)	F	9
13.12T	Marine Structures (A)	Sp	9
13.13T	Plastic Analysis of Structures	Sp	9
13.15T	Welding Engineering (A)	Sp	6
13.16J.T	Properties of Metals	Sp	11
13.20	Energy Conversion Systems and Components	Sp	12
13.21	Ship Propulsion (A)	F	6
13.22	Naval Ship Propulsion (A)	F	12
13.23	Propulsion System Reliability and Control (A)	Sp	9
13.24T	Propulsion Hydrodynamics (A)	F	6
13.25	Advanced Naval Electrical Engineering (A)	Sp*	9
13.30T	Ship Structural Analysis and Design	F	12
13.32T	Ocean Engineering Structures	F	9
13.34T	Ship Structural Design I (A)	F	5
13.35T	Naval Structural Design (A)	F*	5
13.36	Ocean Engineering Structural Design	Sp	5
13.39T	Analysis of Techniques for Fabricating Structures (A)	Sp	6
13.40	Introductory Ship Design	Sp	9

***Offered in Alternate Years**

Department of Naval Architecture and Marine Engineering—*Continued*

13.41	Principles of Ship Design (A)	F	11
13.42	Design of a Waterborne Vehicle (A)	Sp	LAB
13.43	Naval Ship-System Design I (A)	Su	9
13.44	Naval Ship-System Design II (A)	F	5
13.45	Principles of Naval Ship Design (A)	F	9
13.46	Conceptual Design of Naval Ships (A)	Sp	12
13.47J	Special Studies in Systems Engineering (A)	Sp	12
13.50	Computer Application to Marine Problems	Sp	8
13.51	Computer Systems for Naval Architecture and Marine Engineering (A)	Sp	6
13.60	Application of Operational Methods	F	12
13.61	Decision Processes in Ship Operation and Construction (A)	Sp	9
13.62	Shipping Economics (A)	Sp	9
13.64	Hydrospace Vehicles	Sp	6
13.65	Ship Production Analysis (A)	F	6
13.70	Special Problems in Naval Architecture and Marine Engineering I	F, Sp	LAB
13.71	Special Problems in Naval Architecture and Marine Engineering II	F, Sp	LAB
13.72	Methods of Harmonic and Statistical Analysis (A)	Sp	9
13.80T	Mechanical Vibrations (A)	F	9
13.81T	Acoustics and Structural Vibrations	F	9
13.82T	Acoustics and Shock Response of Marine Structures (A)	Sp	9
13.83T	Hydroacoustics (A)	Sp	9
13.84T	Flow Noise (A)	Sp	12
13.92J	Public Policy and Use of the Seas	F	9
13.93	Ocean Engineering Systems	F	6
13.94	Modern Ocean Engineering and International Affairs	Sp	6

Department of Metallurgy and Materials Science

3.54	Corrosion (A)	Sp	8

Department of Civil Engineering

1.631	Advanced Hydromechanics I (A)	F	9
1.632	Advanced Hydromechanics II (A)	Sp	9
1.681	Experimental Hydromechanics (A)	F	6
1.683	Experimental Hydromechanics (A)	Sp	6
1.69	Waves and Coastal Processes (A)	Sp	9
1.70	Mechanics of Sediment Transport (A)	Sp	6

The Institute also offers a graduate degree program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Naval Architecture and Marine Engineering

Keil, Alfred A. H., Dr. Rer. Nat., Head of Department and Professor of Naval Architecture and Marine Engineering

Abkowitz, Martin A., Ph.D., Professor of Naval Architecture

Cummings, Damon E., Ph.D., Assistant Professor of Naval Architecture

Devanney, John W., III, Ph.D., Assistant Professor of Naval Architecture

Evans, John H., B.Eng., Professor of Naval Architecture

Frankel, Ernst G., Mar.Mech.E., Professor of Marine Engineering

Department of Naval Architecture and Marine Engineering—*Continued*

Frisch, Franz A. P., Diplom Ingenieur, Lecturer of Marine Transportation
Horn, Dean A., Nav.E., Professor of Naval Construction
Jones, Norman, Ph.D., Assistant Professor of Naval Architecture
Junger, Miguel C., Sc.D., Senior Lecturer of Hydroacoustics
Kerwin, Justin E., Ph.D., Professor of Naval Architecture
Leehey, Patrick, Ph.D., Professor of Naval Architecture
Mandel, Philip, B.S., Professor of Naval Architecture
Mansour, Alaa, Ph.D., Assistant Professor of Naval Architecture
Masubuchi, Koichi, D.Eng., Associate Professor of Naval Architecture
Milgram, Jerome H., Ph.D., Assistant Professor of Naval Architecture
Newman, John N., Sc.D., Associate Professor of Naval Architecture
Padelford, Norman J., Ph.D., Professor of Political Science
Pellini, William S., B.S., Senior Lecturer of Ocean Engineering Materials
Powell, S. Curtis, Dott.Ing., Associate Professor of Marine Engineering
Reed, Sherman C., Nav.E., Associate Professor of Naval Engineering
Romberg, Bernhard W., Ph.D., Lecturer of Computer Systems Applications

Department of Metallurgy and Materials Science

Floe, Carl F., Sc.D., Professor of Metallurgy
Uhlig, Herbert H., Ph.D., Professor of Metallurgy

Department of Electrical Engineering

Edgerton, Harold E., Sc.D., Professor of Electrical Measurements, Emeritus

Department of Civil Engineering

Cross, Ralph H., III, Ph.D., Assistant Professor of Civil Engineering
Gelhar, Lynn W., Ph.D., Assistant Professor of Civil Engineering
Harleman, Donald R. F., Sc.D., Professor of Civil Engineering
Ippen, Arthur T., Ph.D., Professor of Civil Engineering
Mei, Chiang C., Ph.D., Associate Professor of Civil Engineering
Perkins, Frank E., Sc.D., Associate Professor of Civil Engineering

To obtain further information, address all inquiries directly to:

Ocean Engineering Information
Admissions Office, Room 3-108
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

UNIVERSITY OF MIAMI
Coral Gables, Florida

Facilities include those of the Institute of Marine Sciences and the School of Engineering. At the Institute, research vessels, extensive oceanographic laboratories, underwater acoustics laboratory, marine corrosion laboratories, ocean measurements facilities, classroom space, library, and digital computer are provided. At the School of Engineering, laboratories in Civil, Electrical, Industrial, and Mechanical Engineering are available to the Ocean Engineering students for course work and research.

The following degrees are offered in the areas indicated:

1. **M.S. in Ocean Engineering**. This is an interdisciplinary program consisting of a minimum of 30 credits at the graduate level, of which six are for a thesis. At least 12 credits must be at the 600 level (open to graduate students only) excluding thesis. PCO 501, PCO 503, and OEN 607 are required of all ocean engineering students and at least 12 credits must be in either ocean engineering or ocean related subjects. The areas of specialization center about underwater structures and coastal engineering, marine corrosion, ocean measurements, and underwater acoustics.

2. **Ph.D.** programs are available **in the Civil Engineering and Mechanical Engineering Departments with specialization in Ocean Engineering.**

3. **Undergraduate programs in Ocean Engineering are available as options in the Civil, Electrical, Industrial, and Mechanical Engineering Departments.** These are fully accredited programs in their respective traditional areas, but allow specialization in Ocean Engineering through choice of electives.

The Ocean Engineering, Physical and Chemical Oceanography, and the Electrical, Civil, Industrial, and Mechanical Engineering Departments offer courses related to Ocean Engineering. The following courses are offered in conjunction with the above programs:

PCO 501	General Oceanography	3
PCO 503	General Oceanography Laboratory	1
OEN 531	Oceanographic Measurements	3
OEN 535	Underwater Acoustics	3
OEN 541	Marine Corrosion	2
OEN 607	Ocean Engineering Seminar	1
OEN 610	Applied Ocean Hydrodynamics	2
OEN 611	Engineering of Ocean Systems	2
OEN 641	Marine Corrosion Laboratory	1
OEN 642	Advanced Marine Corrosion	2
OEN 690	Advanced Topics in Ocean Engineering I	3
OEN 691	Advanced Topics in Ocean Engineering II	3
CEN 509	Coastal Engineering	3
CEN 691	Underwater Structures	3
PCO 613	Advanced Underwater Acoustics	3
RES 600	Thesis	6

Many related courses are available in the School of Engineering and at the Institute of Marine Sciences. These are too numerous to list and are available in the University bulletin.

The University also offers a graduate program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Ocean Engineering

Steinberg, John C., Ph.D., Chairman and Professor of Ocean Engineering, Underwater Acoustics

Weinberg, Norman L., Ph.D., Associate Professor of Electrical and Ocean Engineering, Underwater Acoustics and Ocean Instrumentation

Chang, Wen F., Ph.D., Professor of Civil Engineering, Underwater Structures

Department of Ocean Engineering—*Continued*

Yacoub, Kamal, Ph.D., Associate Professor of Electrical and Ocean Engineering, Oceanographic data analysis

Michel, John F., M.S., Research Scientist, Coastal Engineering and Underwater Structures

Compton, Kenneth G., M.S., Professor of Ocean Engineering, Marine Corrosion

Kronengold, Morton, B.S., Assistant Professor of Ocean Engineering, Ocean Measurements and Underwater Acoustics

DeFerrari, Harry, Ph.D., Assistant Professor of Ocean Engineering, Underwater Acoustics

Frohlich, Hans, Dipl. Ing., Associate Professor of Mechanical Engineering, Coring techniques

Knopf, William C., Ph.D., Dean, School of Engineering, Special Lectures on Ocean Engineering

To obtain further information, address all inquiries directly to:

Dr. John C. Steinberg
Chairman, Ocean Engineering Department
University of Miami
Coral Gables, Florida 33124

THE UNIVERSITY OF MICHIGAN
Ann Arbor, Michigan

The department's research facilities include two ship model basins capable of testing models up to 18 feet in length. One basin is 360 feet long, 22 feet wide, and 11 feet deep. It is spanned by a traveling carriage that tows the model through the water and carries observers and instrumentation for measuring speed, resistance, and so forth. Self-propelled tests are also carried out. The tank is equipped with a false bottom allowing analysis of shallow water effects. It also has a wave-maker allowing model tests in head-on or overtaking waves. The other basin is 100 feet by 60 feet in plan, and 6 feet deep. It is used for ship model tests using radio-controlled, self-propelled models. In its present condition it is used primarily for maneuvering tests. Upon completion of the wave-maker (now under construction) the tank will also allow seakeeping tests with waves coming from any direction.

Other facilities include several small instructional items such as a demonstration propeller tunnel. In addition, the department has available to it all the appurtenances of the Engineering College, notably the Fluids Laboratory (110,000 square feet), the Engineering-Transportation Library (300,000 volumes) and an IBM 360-67-computer system.

The following degrees are offered:

1. **BSE (Naval Architecture and Marine Engineering)**

The undergraduate student elects one of three options, each of which leads to the degree B.S.E. (Nav. Arch. & Mar. E.)–Bachelor of Science in Engineering (Naval Architecture and Marine Engineering); he thus acquires competence in one division of the field while obtaining a good introduction to the rest. These options are:

Option 1. Naval Architecture relates to the design of ship hulls and includes such topics as form, strength, stability, arrangements, resistance, powering, and methods of preliminary design.

Option 2. Marine Engineering places emphasis on the design of various types of propelling and auxiliary machinery and on their relation to the ship as a whole.

Option 3. Maritime Engineering Science stresses preparation for research and provides a stronger grounding in basic engineering science with less emphasis on design than that found in the other options. It will be normal for students in this option to spend an extra term and receive an additional degree in mathematics or engineering mechanics or to do graduate work toward an M.S.E. degree from this or other departments.

Students wishing to obtain an additional B.S.E. degree in aerospace engineering may do so under a combined program which allows for substantial substitution of courses in one curriculum for those required in the other.

Candidates for the degree B.S.E. (Nav. Arch. & Mar. E.)–Bachelor of Science in Engineering (Naval Architecture and Marine Engineering)–are required to complete the following program:

A. Subjects to be elected or equivalent proficiencies to be demonstrated.

B. Professional and advanced subjects and electives.

Group A Subjects

Group A includes foundation subjects in those fundamental areas of communication, mathematics, and basic sciences that are common to all programs.

Appropriate college credit may be allowed a student for subjects in which he has qualified through the Advanced Placement Program as covered under Admission as a Freshman. Another possibility for attaining advanced credit is through demonstration of equivalent proficiency in any of the Group A subjects.

Generally, suitable Group A subjects, with the possible exception of Engineering Graphics, are offered in liberal arts colleges and community colleges; under conditions of equivalency and satisfactory performance, they are transferable to any engineering program.

Credit is not granted for work experience.

Group B Subjects

Group B for each program is composed basically of "professional and advanced subjects and electives," consisting of a total of 95 credit hours, that will prepare the student for the particular field of engineering he selects.

2. **MSE (Naval Architecture and Marine Engineering)**

Requirements for the degree include 30 credit hours of graduate studies, approved by the graduate adviser, including at least 10 credit hours of course work in Naval Architecture and Marine Engineering exclusive of those required for the degree of B.S.E. (Nav. Arch. & Mar. E.), a minimum of 5 credit hours of mathematics beyond undergraduate degree level, and cognate subjects. A thesis may also be required. If the applicant's undergraduate work is in a field other than naval architecture and marine engineering, or taken at a non-accredited school, the program adviser may require that he first enter the College of Engineering as an undergraduate special student for one or more terms.

It is possible to obtain the Master of Science in Engineering degree in the combined fields of Naval Architecture and Marine Engineering, and another engineering field, after the student has first been admitted to one department. To do so he must be able to present an acceptable study program endorsed by the program advisers of the two departments involved, showing a minimum of 36 hours of graduate-level courses. The program outline must then be presented to the Dean of the Graduate School for final approval.

3. **Naval Architecture (Professional Degree)**

The professional degree program requires a minimum of thirty credit hours of work beyond the Master of Science in Engineering level or its equivalent, taken at this University with a grade average of B or better. Successful completion of a qualifying examination for admission to candidacy is required.

The total graduate program shall include:

a. At least twenty-four hours in the area of the department or program cited in the degree. The department or program advisers may specify these hours in greater detail.

b. At least six hours devoted to a research, design, or development problem, including a written report covering the work. A committee of faculty members will supervise the work, approve the report, and conduct a final oral examination on this work.

c. At least three courses in cognate fields other than mathematics.

d. At least nine hours in mathematics beyond the Bachelor of Science in Engineering mathematics requirements of the department cited in the degree.

4. **Ph.D.**

The doctor's degree is conferred in recognition of marked ability and scholarship in some relatively broad field of knowledge. A part of the work consists of regularly announced graduate courses of instruction in the chosen field and in such cognate subjects as may be required by the committee. In addition, the student must pursue independent investigation in some subdivision of the selected field and must present the result of his investigation in the form of a dissertation.

A student becomes an applicant for the doctorate when he has been admitted to the Horace H. Rackham School of Graduate Studies and has been accepted in a field of specialization. No assurance is given that he may become a candidate for the doctorate until he has given evidence of superior scholarship and ability as an original investigator.

There is no general course or credit requirement for the doctorate. In most areas a student must pass a comprehensive examination in his major field of specialization, which tests his knowledge in that field and in the supporting fields, before he will be recommended for candidacy for the doctorate. A special doctoral committee is appointed for each applicant to supervise the work of the student both as to election of courses and in preparation of the dissertation.

Each student must demonstrate reading competence in one professionally acceptable language, in addition to English, before he can be accepted as a candidate for the Ph.D. degree. The language will be chosen, in consultation with the student, by the department chairman or program chairman or his designated representative. French, German, Russian, or any other language acceptable to the department chairman or program chairman may be offered. Individual departments or programs may have requirements for more than reading competence or more than one language.

The requirement for demonstration of reading competence may be satisfied in any one of the following ways:

1a. By courses—French, German, or Russian 112 completed with a grade of B or better.
1b. By courses in various languages judged of equivalent difficulty by the Graduate School.
2. By reading examination administered by the Graduate School.
3. By reading examination administered by the department.
4. By the Graduate Foreign Language Examination (Educational Testing Service) in French or German only.

A pamphlet that describes the general procedure leading to the doctorate is available in the Graduate School office upon request.

The following courses are offered in conjunction with the above programs:

Department of Naval Architecture and Marine Engineering

200	Introduction to Practice	3
201	Form Calculations and Static Stability I	3
300	Form Calculations and Static Stability II	2
310	Structural Design I	3
330	Marine Machinery I	3
331	Marine Machinery II	3
350 (Meteor.–Ocean. 350)	Ocean Engineering	3
400	Maritime Engineering Management	2
401	Small Craft Design	2
402	Small Commercial Vessel Design	2
410	Stress Analysis of Ship Structures	2
420	Resistance, Propulsion, and Propellers	4
430	Design of Marine Power Plants I	3
431	Design of Marine Power Plants II	3
440	Ship Dynamics	3
446	Theory of Ship Vibrations I	3
470	Ship Design I	3
471	Ship Design II	2
472	Structural Design II	2
473	Design of Marine Power Plants III	3
490	Directed Study, Research, and Special Problems I and II	To be arranged
510	Advanced Structural Design	To be arranged
511	Directed Research in Ship Structure	To be arranged
520	Advanced Ship Model Testing	2–3
521	Research in Ship Hydrodynamics	To be arranged
525	Naval Hydrodynamics I	3
526	Naval Hydrodynamics II	3
530	Theory of Ship Vibrations II	2
571	Advanced Ship Design I and II	To be arranged
572	Economics of Ship Design and Operation	2
590	Advanced Reading and Seminar in Marine Engineering I and II	To be arranged
591	Advanced Reading and Seminar in Naval Architecture I and II	To be arranged
592	Master's Thesis	3
620	Advanced Propeller Theory and Cavitation	2
625	Naval Hydrodynamics III	To be arranged
630	Nuclear Ship Propulsion	3
900	Doctoral Thesis I and II	To be arranged

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Benford, Harry, BSE, Department Chairman and Professor of Naval Architecture and Marine Engineering
Bhattacharyya, Rameswar, Dr. Ing., Lecturer
Couch, Richard B., AE, Professor of Naval Architecture and Marine Engineering
D'Arcangelo, A. M., MSE, Professor of Naval Architecture and Marine Engineering
Kaldjian, Movses, Ph.D., Assistant Professor of Engineering Mechanics
Michelsen, Finn C., Ph.D., Professor of Naval Architecture and Marine Engineering and Director of Ship Hydrodynamics Laboratory
Moss, James, MSE, Lecturer and Assistant Director of Ship Hydrodynamics Laboratory
Nowacki, Horst, Dr.S., Associate Professor of Naval Architecture and Marine Engineering
Ogilvie, T. Francis, Ph.D., Associate Professor of Naval Architecture and Marine Engineering
Sharma, Som Deo, Dr.Ing., Lecturer
West, George L., Jr., BSE, Professor of Naval Architecture and Marine Engineering and Professor of Nuclear Engineering
Woodward, J. B., III, Ph.D., Professor of Naval Architecture and Marine Engineering
Yagle, Raymond A., MSE, Professor of Naval Architecture and Marine Engineering

To obtain further information, address all inquiries directly to:

(A) For undergraduate work:
Professor John B. Woodward, III
Department of Naval Architecture and Marine Engineering
West Engineering Building
Ann Arbor, Michigan 48104

(B) For graduate work:
Professor T. Francis Ogilvie
Department of Naval Architecture and Marine Engineering
West Engineering Building
Ann Arbor, Michigan 48104

UNIVERSITY OF NEW HAMPSHIRE
Durham, New Hampshire

Study and research in the application of engineering to ocean exploration and exploitation is centered in the Engineering Design and Analysis Laboratory (EDAL), which is sponsored by all of the engineering departments. Faculty and students in engineering join in engineering projects aimed at solving real problems in ocean science and technology and carry their developments through actual sea trials whenever possible. The Laboratory maintains cordial but informal relationships with several oceanographic institutions, both private and government operated, which permit staff and students to have open ocean experience as well as the use of model tank testing facilities.

The Laboratory occupies 2000 ft. of floor space in Kingsbury Hall in the College of Technology, including a pressure test facility, an instrumentation laboratory and a student shop. Students and staff have access to all of the University facilities such as the Computation Center, the Electron Microscope, the State Engineering Test Station equipment for materials analysis and testing, and a fully equipped machine shop.

The degree of **Master of Science** is offered by the Departments of Chemical, Civil, Electrical, and Mechanical Engineering. For the degree, at least 30 credits must be earned, including a minimum of eight credits in courses, not including thesis, numbered 800–898. Department requirements relative to the thesis vary. (See Graduate Catalogue.)

The following courses are offered in conjunction with the above degree programs:

Department of Chemical Engineering

813	Introduction to Fluid Dynamics	3
815	Heat Transfer	3
816	Diffusive Mass Transfer	3
823	Advanced Chemical Engineering Thermodynamics	3
895, 896*	Graduate Independent Study	2–4
899*	Master's Thesis	1–6

Department of Civil Engineering

742	Hydrology	3
784	Topics in Structural Engineering	3
841–842	Advanced Hydraulics	3
863–864	Soil Mechanics	3
895, 896*	Civil Engineering Problems	2–3
899*	Master's Thesis	6–9

Department of Electrical Engineering

695*	Electrical Engineering Projects	1–4
711	Digital Systems	4
741	Fundamentals of Acoustics	3
758	Communication Systems	4
781	Instrumentation	4
782	Control Systems	4
851–852	Advanced Control Systems	6
891–892*	Research	6
899*	Master's Thesis	6

Department of Mechanical Engineering

671	Naval Architecture I	3
695, 696*	Mechanical Engineering Project	1–3
736	Analytical Fluid Dynamics	3

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*Projects, research or theses of the Engineering Design and Analysis Laboratory are structured to include undergraduate or graduate students who wish to participate in an ongoing project oriented toward ocean problems. Current efforts are in hyperbaric systems for diver-scientists, oceanographic telemetry, control systems for dynamic oceanographic instrumentation, buoy technology, manned submersible vehicles, bioengineering concerned with marine vertebrates.

Department of Mechanical Engineering—*Continued*

746	Control of Physical Systems	3
772	Naval Architecture II	3
801	Continuum Mechanics	4
808	Theoretical Aero/Hydro-Mechanics	3
812	Vibrations of Continuous Media	4
829	Theory of Plates and Shells	4
897*	Master's Project	4
899*	Master's Thesis	6–10

College of Technology

601	Statistical Methods in Engineering and Physical Science	3
780	Engineering Analysis	2–3

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Chemical Engineering

Zimmerman, Oswald T., Ph.D., Professor and Chairman of Chemical Engineering
Gehrhardt, Henry M., Ph.D., Assistant Professor of Chemical Engineering

Department of Civil Engineering

Zoller, J. Harold, Ph.D., Professor and Chairman of Civil Engineering
Klotz, Louis H., Ph.D., Assistant Professor of Civil Engineering

Department of Electrical Engineering

Murdoch, Joseph E., Ph.D., Professor and Chairman of Electrical Engineering
Blanchard, Fletcher A., Jr., M.S., Professor of Electrical Engineering and Acting Director of EDAL
Dalton, William L., M.S., Instructor of Electrical Engineering
Glanz, Filson H., Ph.D., Assistant Professor of Electrical Engineering
Melvin, Donald W., M.E., Associate Professor of Electrical Engineering
Pokoski, John L., Ph.D., Assistant Professor of Electrical Engineering
Skutt, H. Richard, Ph.D., Associate Professor of Electrical Engineering
Winn, Alden L., S.M., Professor of Electrical Engineering

Department of Mechanical Engineering

Corell, Robert W., Ph.D., Professor and Chairman of Mechanical Engineering
Allmendinger, E. Eugene, M.S., Associate Professor of Mechanical Engineering
Azzi, Victor D., D.Eng., Associate Professor of Mechanics
Hochgraf, Frederick G., M.S., Associate Professor of Materials Science
Savage, Godfrey H., Engr., Professor of Mechanical Engineering and Director of EDAL
Stolworthy, E. Howard, B.S., Professor of Mechanical Engineering and Executive Officer of Office of Marine Science and Technology
Taft, Charles K., Ph.D., Professor of Mechanical Engineering

To obtain further information, address all inquiries directly to:

Office of Marine Science and Technology
Kingsbury Hall
University of New Hampshire
Durham, New Hampshire 03824

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*Projects, research or theses of the Engineering Design and Analysis Laboratory are structured to include undergraduate or graduate students who wish to participate in an ongoing project oriented toward ocean problems. Current efforts are in hyperbaric systems for diver-scientists, oceanographic telemetry, control systems for dynamic oceanographic instrumentation, buoy technology, manned submersible vehicles, bioengineering concerned with marine vertebrates.

THE MARITIME COLLEGE OF THE STATE UNIVERSITY OF NEW YORK
Fort Schuyler, Bronx, New York

The Engineering Wing (Tode Hall) of the new Science and Engineering Building accommodates the various laboratories of the college's Engineering Department. The analog computer laboratory is equipped with two fully expanded Electric Associates Inc. (EAI) TR-20 computers and one EAI 580. These machines and associated equipment are used by students to model and solve engineering problems involving calculus, differential equations, and advanced mathematics in real time terms.

The Electrical and Electronic Engineering Laboratory is provided with extensive instrumentation and equipment that permits the students to perform experiments in electronics, electrical circuits and machinery, both A.C. and D.C.

The Transport Processes Laboratory is a thermal and fluid mechanics facility. The equipment is used by students in performing experiments and study projects in subsonic and supersonic flow, machinery tests for compressible and incompressible media, conduction, convection and radiation.

The Marine Engineering Laboratory has an instrumented sixty-horsepower turbine power plant with its own 200 psi 10,000 pound per hour package steam generator. In addition, it has test equipment and instrumentation associated with diesels, gasoline engines, gas turbines, fuel cells, an air compressor and an air conditioner and refrigeration test facility.

The Systems and Controls laboratory has an Autodynamics Inc. model 500 control systems trainer as well as four test stations with air, gas, water, steam, and electrical; 60 and 400 cycle A.C. and D.C. systems available. The test stations are used to test and analyze various types of systems and control systems that can be temporarily installed for that purpose.

The Manufacture Processes Laboratory has lathes, milling machines, shapers, drill presses, welding booth facilities, metalizing and heat treating equipment. All of these facilities are used by the students as part of their educational and training requirements.

The Strength of Materials laboratory has extensive testing equipment including a 200,000 lb. universal testing machine, three (3) 60,000 lb. universal testing machine, two (2) 10,000 in lb. torsion machines, a warner-swasey vibration-fatigue machine, and assorted accessories.

The College's training vessel EMPIRE STATE IV has an 8500 SHP power plant which is extensively instrumented with equipment including a shaft torsionmeter, laboratory type pressure and temperature sensing devices, and fourteen (14) flowmeters that measure steam, water, gases, fuel oil and air. The instrumentation system is integrated so that basic design parameters, such as lbs. fuel per SHP hr. is in continuous readout.

The College's 600-foot pier provides docking space for the EMPIRE STATE IV. A boat shed adjacent to the pier is used to house and to launch and retrieve the small boats. A tidal gauge station is situated close to the pier.

The college offers three **Bachelor of Engineering** curricula at its main campus: **Marine Engineering, Naval Architecture, and Electrical Engineering**. The summer sea term provides for education and training aboard the college training vessel EMPIRE STATE IV.

Each curriculum is accredited and in addition registered for professional engineering licensure in the state of New York. This means students may take Parts I and II of the New York State Professional Engineers examination during their senior year; the U.S. Coast Guard Third Engineer's operating engineer's license examination; and, if acceptable to the U.S. Navy, they can obtain an Ensign's commission in the Naval Reserve upon graduation.

All three engineering curricula follow a common core of subjects for the first two full years—Mathematics, Physics, Chemistry, Humanities, Basic Engineering Sciences and operational courses.

The Marine Engineering curriculum in the last two years specializes in courses in Engineering Analysis, Solid Mechanics, Transport Processes, Electrical Engineering, Engineering Economics and Value, Design, Technical Naval Architecture, Controls, Nuclear and Modern concepts, and Humanities and/or socio-economic studies.

The Naval Architecture major studies in his last two years in the course areas of Ship Form and Stability, Ship Structure, Ship Resistance, Electrical Engineering, Vibrators, Propeller Design and

Ship Design. The Naval Architect also has additional courses in the humanities and/or socio-economic studies.

The Electrical Engineer in his junior and senior years will study the areas of Network Analysis, Electromagnetic Systems, Electronics, Random Processes, Communications Theory, Controls and Technical Naval Architecture. The EE student also studies humanities and/or socio-economic studies in each of his upperclass terms.

The College also offers an undergraduate program in marine sciences and training for seagoing officers which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Engineering

Foody, John J., P.E., J.D., Professor and Chairman of Engineering
Femenia, Jose, M.M.E., Assistant Professor of Engineering
Gleicher, Norman J., EIT, Assistant Professor of Engineering
Kramer, Aaron R., P.E., Associate Professor of Engineering
Mathieson, John, M.M.E., Assistant Professor of Engineering
McNeill, Joseph G., Sc.M., Associate Professor of Engineering
Pergament, Stuart P., M.S.E., Assistant Professor of Engineering
Thornton, James K., P.E., Assistant Professor of Engineering
Wennagel, Norman G., P.E., Professor of Engineering
Zubaly, Robert, M.S.M.E., Professor of Engineering

Ship's Staff

Pfleging, Edward F., B.S., Professor and Chief Engineer of Training Ship
Dreyer, Richard C., B.E. (Marine), Ship's Watch Officer and Assistant Instructor
Kuhl, William R., B.E. (Marine), Ship's Watch Officer and Assistant Instructor
O'Neill, John M., B.E., (Marine), Ship's Watch Officer and Assistant Instructor
Rowen, Alan J., (Marine), Ship's Watch Officer and Assistant Instructor

To obtain further information, address all inquiries directly to:

Dr. John J. Foody, P.E.
Professor and Chairman
Department of Engineering
State University of New York Maritime College
Fort Schuyler, Bronx, New York 10465

NEW YORK UNIVERSITY
University Heights, New York, New York

The School of Engineering and Science of New York University has expanded its program in Ocean Engineering. Options in Ocean Engineering are offered by five departments in programs that combine traditional engineering disciplines with environmental courses.

The following degrees are offered in the areas indicated:

1. **M.S. in Aeronautics and Astronautics**
2. **M.S. in Chemical Engineering**
3. **M.S. in Civil Engineering**
4. **M.S. in Mechanical Engineering**
5. **M.S. in Metallurgy**

Candidates electing the ocean engineering option will be required to attend an OCEAN ENGINEERING SEMINAR in which the contributions of the engineering sciences to the design and fabrication of equipment used over, on, or in the oceans will be studied.

The program is aimed at providing the latest and most pertinent information applicable to the solution of the engineering problems that arise in the design of objects used for the exploration, scientific study, and exploitation of the oceans. The program will be coordinated with courses concerning the oceans as an environment to be given by the Department of Meteorology and Oceanography.

The following courses are offered in conjunction with the above programs:

Aeronautics and Astronautics
- Foundations of Hydrodynamics
- Topics in Hydrodynamics

Chemical Engineering
- Materials for Underseas Operations
- Ocean Industrial Operations

Civil Engineering
- Forces on Marine Structures
- Marine Structures
- Coastal Engineering

Mechanical Engineering
- Environmental Engineering and Control in Confined Spaces
- Design Analysis of Underwater Structures and Vessels

Metallurgy and Materials Science
- High Pressure Effects in Metallurgy
- Corrosion and Corrosion Control

Meteorology and Oceanography
- Transmission of Sound in Sea Water
- Electromagnetic Properties of Sea Water
- Oceanography and Space Technology

The University also offers undergraduate and graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Aeronautics and Astronautics
- Isom, Marris P., Ph.D., Associate Professor
- Werner, Jack E., Ph.D., Associate Professor

Department of Chemical Engineering
- Shaffer, Richard F., M.S., Adjunct Professor

Department of Civil Engineering
- Gidlund, Erick R., Ph.D., Assistant Professor

Department of Electrical Engineering
- Greenstein, Philip, M.S., Professor

Department of Mechanical Engineering
Mueller, Wheeler K., Jr., Ph.D., Professor
Department of Metallurgy and Materials Sciences
Cadoff, Irving B., Eng. Sc.D., Associate Professor
Margolin, Harold, D.Eng., Professor
Department of Meteorology and Oceanography
Pierson, Willard J., Jr., Ph.D., Professor (Chairman)

To obtain further information, address all inquiries directly to:

Office of Assistant Dean
Graduate Division
School of Engineering and Science
New York University
University Heights, New York, New York 10453

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island

The shore facilities and ship facilities of the Graduate School of Oceanography are available to ocean engineering faculty and graduate students. In addition, the College of Engineering laboratories include a well-equipped soils and sediments laboratory, an underwater acoustics laboratory in a new building, a sub-critical reactor, many wave and model tanks in the several engineering buildings. Nearby Navy and industrial laboratories have made much of their facilities available for cooperative research work.

The following degrees are offered by the University:

1. **Master of Science in Ocean Engineering.**
2. **Doctor of Philosophy in Ocean Engineering.**

Many graduate engineering courses in the classic departments are available to ocean engineering majors and applicable to their programs of study. In addition to these, the following ocean engineering courses are offered.

OE 134 (ChE 134)	Corrosion and Corrosion Control
OE 201, 202	Ocean Engineering Seminar
OE 203, 204	Ocean Engineering Principles
OE 210	Engineering Ocean Mechanics
OE 231	Introduction to the Analysis of Oceanographic Data
OE 287	Submarine Soil Mechanics
OE 291, 292	Special Problems
OE 321	Underwater Acoustics I
OE 322	Underwater Acoustics II
OE 351, 352	Advance Design
OE 391, 392	Special Problems
OE 206 (ME 206)	Environmental Control in Ocean Engineering
OE 215 (Geol 215)	Coastal Engineering Geology
OE 264 (CE 264)	Marine Structural Design
OE 353, 354	Ocean Engineering Systems Studies

The University also offers undergraduate and graduate programs in marine sciences and an associate degree program in fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Middleton, F. H., Dr.Eng., Chairman and Professor
Brown, G.A., Sc.D., Professor
Nacci, V. A., M.S., Professor
Schenck, H. Van N., Jr., M.S., Professor
White, F. M., Jr., Ph.D., Professor
Haas, R. B., M.S., Associate Professor
Stanislao, J., M.S., Associate Professor
Rose, V. C., Ph.D., Assistant Professor
Soltz, G. C., Ph.D., Assistant Professor

To obtain further information, address all inquiries directly to:

F. H. Middleton, Chairman
Ocean Engineering Department
College of Engineering
University of Rhode Island
Kingston, Rhode Island 02881

STEVENS INSTITUTE OF TECHNOLOGY
Hoboken, New Jersey

The Davidson Laboratory is the center for research in ocean engineering at Stevens. The laboratory is staffed by 40 scientists and engineers and 55 support personnel engaged in more than 60 long-range research and development projects. The major facilities include: (1) a 130 ft. towing tank suitable for model studies of ships and other structures in regular and irregular seas; (2) a 75 ft. square basin for model tests on course stability and maneuvering characteristics of ships and submersibles; and (3) a 300 ft. towing tank for high speed testing; (4) an enclosed wind tunnel with 2½ ft. x 3½ ft. x 12 ft. test section and with a maximum wind speed capability of 200 ft/sec. Stevens has recently purchased and renovated a former luxury liner for use as a dormitory, permanently moored in the Hudson River immediately adjacent to the campus. A small oceanographic laboratory is being established aboard this ship.

The following degrees are offered in ocean engineering:

1. **Master of Engineering (Ocean).** The following courses are required of all students: OE 101-102, OE 103, OE 200, OE 201, and OE 203. The remaining credits required for the Master of Engineering (Ocean) degree can be earned by taking 15 credits of additional course work in a particular area of concentration or by taking 10 credits of course work and writing a master's thesis. Potential doctoral candidates are encouraged to select the thesis option in order to gain experience for the doctoral dissertation by first planning, organizing, performing, and reporting on a research problem of considerably less scope than that expected for the dissertation research.

2. **Doctor of Philosophy.** The program leading to the Doctor of Philosophy degree is designed to develop the student's capability to perform basic research or high level design in ocean engineering. All students entering the doctoral program must have a master's degree or equivalent. Students who have not earned their master's degrees in the Department of Ocean Engineering must take all of the courses required for the Master of Engineering (Ocean) degree or must have satisfactorily completed comparable courses in other institutions. In addition to having completed the above requirements, all doctoral candidates must pass the qualifying examination which includes not only an oral examination to test the student's capability for advanced study, but also an evaluation of his ability to write effectively. The student may demonstrate his writing ability by presenting either an acceptable master's thesis or a critical review of several technical articles dealing with some aspect of ocean engineering. Doctoral candidates are expected to concentrate their advanced graduate studies in one of the areas of specialization presently offered in the department: Free Structures in the Ocean, Fixed Structures in the Ocean, or Ocean Instrumentation. A fourth area of specialization, Pollution Control, is under development. Additional courses in the Departments of Electrical Engineering, Mathematics and Mechanical Engineering are to be taken by the student to complete his program.

Upon completion of his formal course work and before embarking on his dissertation research, the doctoral candidate must pass the preliminary oral examination and an examination in one foreign language in which pertinent literature is being published in the area of the student's research.

The following courses are offered in conjunction with the above programs:

OE 101	Descriptive Oceanography	2½
OE 102	Descriptive Oceanography II	2½
OE 103	Problems in Ocean Environments	2½
OE 104	Ocean Instrumentation	2½
OE 125	Principles of Naval Architecture I	2½
OE 126	Principles of Naval Architecture II	2½
OE 127	Laboratory in Naval Architecture	2½
OE 150	Stochastic Marine Processes	2½
OE 200	Fluid Dynamics for Ocean Engineering	2½
OE 201	Theoretical and Applied Hydrodynamics	2½
OE 203	Dynamic Oceanography I	2½
OE 204	Dynamic Oceanography II	2½
OE 215	Estuarine Oceanography	2½

OE 220	Dynamics of Ocean Waves	2½
OE 221	Motion of Vessels in Waves	2½
OE 222	Stability of Propelled and Towed Bodies	2½
OE 223	Design of Marine Propulsors	2½
OE 224	Hydrodynamics of High-Speed Marine Craft I	2½
OE 225	Hydrodynamics of High-Speed Marine Craft II	2½
OE 230	Buoy Design	2½
OE 231	Vibrational Reponse of Ocean Structures	2½
OE 232	Special Topics in Corrosion	2½
OE 233	Soil Mechanics in Oceans and Estuaries	2½
OE 240	Underwater Acoustics	2½
OE 241	Instrumentation for Ocean Sensors	2½
OE 242	Air-Sea Interactions: Theory and Measurement	2½
OE 243	Special Topics in Ocean Instrumentation	2½
OE 250	Optimal Control of Marine Systems	2½
OE 400	Special Problems	1–3
OE 401	Special Problems	1–3
OE 500	Thesis in Ocean Engineering	5
OE 600	Research in Ocean Engineering	

The instructional staff for the courses listed above consists of the following:

Department of Ocean Engineering

Breslin, J. P., D.Sc., Chairman and Professor of Ocean Engineering
Arase, Elizabeth M., Ph.D., Associate Professor of Ocean Engineering
Arase, Tetsuo, Ph.D., Associate Professor of Ocean Engineering
Savitsky, Daniel, M.S., Associate Professor of Ocean Engineering
Hires, Richard I., Ph.D., Assistant Professor of Ocean Engineering
Henry, Charles J., D.Sc., Research Associate Professor of Ocean Engineering
Numata, Edward, M.S., Research Associate Professor of Ocean Engineering
Strumpf, Albert, Ph.D., Research Associate Professor of Ocean Engineering
Kim, Cheung Hun, Dr. Ing., Visiting Lecturer in Ocean Engineering

To obtain further information, address all inquiries directly to:

Dr. Richard I. Hires
Department of Ocean Engineering
Stevens Institute of Technology
Castle Point Station
Hoboken, New Jersey 07030

TEXAS A&M UNIVERSITY
College Station, Texas

Texas A&M University's Coastal and Ocean Engineering Laboratory has many facilities for research teaching. There is a 120-foot long, 3-foot deep and 2-foot wide two-dimensional wave tank in which mechanically and/or wind-generated wave phenomena may be investigated. Also, currents may be generated in either direction along the tank. As examples, the wave tank may be used to investigate waves generated by wind, storm tides, wave forces, beach scour, wave run-up, sediment transport and response of dynamic systems. A 150-foot long, 4-foot wide and 2-foot deep variable slope recirculating flume with a discharge capacity of 20 cfs is presently under construction. This facility may be used for sediment transport studies, boundary resistance, scour of submerged pipelines, etc.

A 179-foot University-owned research vessel operated by the Department of Oceanography is available to obtain ocean data and to provide instruction in ocean research techniques. The University owns an IBM 360-65-computer which is available for data reduction and analysis and the development of numerical and mathematical models. A 56-foot University-owned research vessel operated by the Civil Engineering Department is also available for work in bays and estuaries and on the Gulf of Mexico.

Texas A&M University offers the **Master of Science, Master of Engineering** and **Doctor of Philosophy degrees in Civil Engineering with a major in Coastal and Ocean Engineering.** The M.S. degree requires a thesis which should embody original work while the M.E. requires that the candidate write one or two reports on some aspect in his field of interest. The Coastal and Ocean Engineering graduate program is interdisciplinary in nature and flexible enough to satisfy the needs of individual students with a variety of backgrounds and a variety of career interests. Applicants with a bachelor's or master's degree in any area of science or engineering who can show evidence of ability to pursue graduate study in Coastal and Ocean Engineering are welcome to this program.

Typically, a student will take sufficient course work to establish a satisfactory background in Fluid Mechanics, Mathematics and Coastal and Ocean Engineering and then select further course work to suit his other interest from optional courses in Coastal and Ocean Engineering, Oceanography, Meteorology, Geology, Hydromechanics and Fluid Mechanics, Mathematics, Environmental Engineering, etc.

The following courses are offered in conjunction with the above programs:

Coastal and Ocean Engineering

C. E. 675	Coastal Engineering I	3
C. E. 677	Coastal Engineering II	3
C. E. 676	Ocean Engineering I	3
C. E. –	Marine Soils and Foundation Engineering	3
C. E. –	Ocean Structures Engineering	3
C. E. –	Coastal Sediment Processes	3
C. E. –	Estuary Hydrodynamics	3
C. E. –	Deep-Ocean and Continental Shelf Dredging	3
C. E. 685	Problems	1–3

Fluid Mechanics, Hydrology and Hydraulic Engineering

C. E. 462	Hydromechanics	3
C. E. 463	Hydrology	3
C. E. 458	Hydraulic Engineering	3
C. E. 630	Hydromechanics	3
C. E. 622	Hydraulics of Drainage Structures	2
C. E. 627	Hydrology	3
C. E. 628	Hydraulic Engineering	3
C. E. 629	Hydraulics of Open Channels	3
C. E. 631	Theory of Fluid Mechanics Models	2
C. E. 674	Flow Through Porous Media	3

Oceanography

Ocean 608	Physical Oceanography	4
Ocean 609	Physical Oceanography	3
Ocean 612	Elements of Ocean Wave Theory	3
Ocean 616	Theory of Ocean Waves	3
Ocean 631	Geological Oceanography	3

Meteorology

Met. 305	General Meteorology	3
Met. 335	Atmospheric Statics	3
Met. 336	Atmospheric Cynamics and Kinematics	3

Geology

Geol. 315	Principles of Sedimentation	3
Geol. 431	Geomorphology	3
Geol. 620	Geology of Ground Water	3
Geol. 625	Advanced Ground Water Geology	3
Geol. 631	Geology in Engineering Construction	3

Mathematics

Math 601	Higher Mathematics for Engineers and Physicists	4
Math 602	Higher Mathematics for Engineers and Physicists	4

Plus, any other math courses containing material applicable to Coastal and Ocean Engineering problems.

Institute of Statistics

Stat. 601	Statistical Analysis	4
Stat. 604	Special Problems in Statistical Computations and Analysis	3

Industrial Engineering–Computer Science

IE 458	Programming of Digital Computers	4
IE 642	Computer Methods in Applied Sciences	4
IE 646	Computer Methods in Applied Sciences	4

Aerospace Engineering

Aero 320	Numerical Methods	3
Aero 475	Aerodynamics of Viscous Fluids	3
Aero 601	Principles of Fluid Motion	4

Mechanical Engineering

M. E. 621	Fluid Mechanics	4

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Coastal and Ocean Engineering Division

Herbich, John B., Ph.D., Head and Professor of Civil Engineering
Garrison, Clarence J., Ph.D., Assistant Professor of Civil Engineering
Sorensen, Robert M., Ph.D., Assistant Professor of Civil Engineering

The following faculty members from other Divisions of the Civil Engineering Department and from various Departments of the University teach special courses in Coastal and Ocean Engineering and Oceanography and are generally concerned with the program.

Davis, William B., Sc.D., Associate Professor of Civil Engineering, Environmental Division
Reid, Robert O., M.S., Professor of Oceanography and Civil Engineering
Schiller, Robert E., Ph.D., Associate Professor of Civil Engineering, Hydraulics & Fluid Mechanics Division
Cochrane, John D., M.S., Associate Professor of Oceanography
Hann, Roy W., Ph.D., Associate Professor of Civil Engineering, Environmental Engineering
Coyle, Harry M., Ph.D., Assistant Professor, Soil Mechanics Division
Lowery, Lee L., Ph.D., Associate Professor of Civil Engineering, Structural Engineering Division
Nowlin, Worth D., Jr., Ph.D., Assistant Professor, Oceanography Department

To obtain further information, address all inquiries directly to:

Mr. H. L. Heaton, Registrar
Texas A&M University
College Station, Texas 77843

THE UNIVERSITY OF TEXAS AT AUSTIN

Austin, Texas

The College of Engineering laboratories are well-equipped for Ocean Engineering research. Modern facilities and instrumentation are available for work in ocean hydrodynamics, structures, soils, saline water conversion, underwater acoustics and nuclear engineering. Numerous supporting laboratories are also available throughout the college. In addition, there are the facilities of The University of Texas Institute of Marine Science at Port Aransas which maintains a fleet of boats particularly suitable for ocean research in nearshore and estuarine waters.

The University offers the following degrees:

1. **Master of Science in Aerospace Engineering and Engineering Mechanics, Chemical, Civil, Electrical, Environmental Health, Mechanical, and Petroleum Engineering.** The program leading to the degree of Master of Science is not fixed but is developed in conferences between the student, the graduate faculty of the department in which the student elects to receive the degree, and a member of the Ocean Engineering Committee. Administrative procedures are handled through the graduate advisor of the department. The M.S. degree requires at least 30 semester hours of work beyond the B.S. degree, six hours of which are usually for a thesis. The specific requirements for the M.S. degree in each department may be found in the Graduate Catalog.

2. **Doctor of Philosophy.** The program leading to the degree of Doctor of Philosophy is worked out between the student, a member of the Ocean Engineering Committee and the departmental Committee on Graduate Studies. Students seeking this degree are expected to have well developed ideas about their goals in graduate study and to a large extent the Ph.D. program is adjusted to the student's interests consistent with general requirements of The University of Texas. The residence, foreign language, and other detailed requirements for the Ph.D. degree may be found in The University of Texas Graduate Catalog.

The Ocean Engineering Program at The University of Texas at Austin is interdisciplinary and combines a basic knowledge of the ocean with engineering specialties for the utilization of the resources of the sea and its boundary. The program is based on a number of core courses with the specific coastal and marine applications and supporting work with application to oceanic systems. Study in Ocean Engineering provides a balanced program including course work, individual study and research. By electing courses from across departmental lines individual programs can be set up in areas such as coastal and estuarine engineering, foundations and construction, mechanical and thermal systems, acoustics, communications and control systems, and ocean resources.

Courses in Ocean Engineering are offered during the regular year at the main campus of The University of Texas by the Departments of Aerospace and Engineering Mechanics, Chemical, Civil, Electrical, Mechanical, and Petroleum Engineering. Courses are also available at The University of Texas Institute of Marine Science at Port Aransas, Texas. A college-wide committee coordinates Ocean Engineering activities at The University of Texas and is available for advising students with their programs.

Department of Aerospace Engineering and Engineering Mechanics

Graduate Courses

ASE 396.22	Man-System Engineering
ASE 396.28	Hydronautics

Department of Chemical Engineering

Undergraduate Course

ChE 365	Water Treatment Engineering: Corrosion

Graduate Course

ChE 381 M	Transport Operations

Department of Civil Engineering (Including Atmospheric Sciences and Environmental Health Engineering)

Undergraduate Course

MET 376	Physical Oceanography

Graduate Courses

CE 397.22	Special Studies in Ocean Engineering
CE 380K.3	Functional Design of Coastal Structures
CE 380M.5	Coastal Engineering
CE 397.24	Estuarine Engineering
CE 394.1	Interaction of Soils and Structures: Selected Problems
CE 394.2	Interaction of Soils and Structures: Methods of Analysis
CE 396M.31	Atmospheric Turbulence
CE 396M.32	Atmospheric Boundary Layers
CE 396M.6	Advanced Dynamic Meteorology
CE 397.54	Streams and Estuaries
CE 397.52	Marine Sciences for Engineers
CE 385L	Water Resources: Water Quality Improvement

Department of Electrical Engineering

Undergraduate Course

EE 379K.14	Introduction to Engineering Acoustics

Graduate Courses

EE 381J	Random Processes in Physical Systems
EE 384L.1	Waves in Material Media
EE 397K.3	Engineering Acoustics

Department of Mechanical Engineering

Undergraduate Courses

ME 379M (Same as EE 397K.14)	Introduction to Engineering Acoustics

Graduate Courses

ME 385Q.2	Acoustical Field Theory
ME 385Q.3	Ocean Sound Propagation
ME 389Q.2	Design of Nuclear Systems
ME 397.40	Oceanic Transport Phenomena
ME 389Q.4	Similitude and Model Design

Department of Petroleum Engineering

PE 383.6	Rock Mechanics I
PE 383.8	Rock Mechanics II
PE 383.4	Offshore Drilling and Production Operations
PE 383.2	Advanced Well Logging and Correlation

The University also offers a graduate program in marine science which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Aerospace Engineering and Engineering Mechanics

Bertin, J. J., Ph.D., Assistant Professor
Konecci, E. B., Ph.D., Professor
Tapley, B. D., Ph.D., Professor and Chairman

Department of Chemical Engineering

Wissler, E. H., Ph.D., Chairman and Professor

Department of Civil Engineering

Cox, W. R., Ph.D., Assistant Professor
Eckenfelder, W. W., M.C.E., Professor
Fruh, E. G., Ph.D., Assistant Professor
Gloyna, E. F., Dr. of Engr., Professor and Director, Environmental Health Engineering Labs., Director, Center for Research in Water Resources
Jehn, K. H., M.S., Associate Professor and Director, Atmospheric Science
Levine, J., Ph.D., Assistant Professor
Masch, F. D., Ph.D., Professor

Department of Civil Engineering–*Continued*
Matlock, H., M.S., Professor
Moore, W. L., Ph.D., Professor
Reese, L. C., Ph.D., Chairman and Professor
Wagner, N. K., Ph.D., Assistant Professor

Department of Electrical Engineering
Bostick, F. X., Ph.D., Associate Professor
Gregg, W. D., Ph.D., Assistant Professor
Hixson, E. L., Ph.D., Associate Professor
Smith, H. W., Ph.D., Professor
Straiton, A. W., Ph.D., Chairman and Professor

Department of Mechanical Engineering
Carter, W. J., Ph.D., Professor
Gage, S. J., Ph.D., Assistant Professor
Gruber, G. J., Ph.D., Assistant Professor
Helfinstine, R. A., Ph.D., Assistant Professor

Department of Petroleum Engineering
Coats, K. H., Ph.D., Associate Professor
Gray, K. E., Ph.D., Chairman and Professor
Jessen, F. W., Ph.D., Professor
Pirson, S. J., D.Sc., Professor

To obtain further information, address all inquiries directly to:

Professor Frank D. Masch
Department of Civil Engineering
The University of Texas at Austin
Austin, Texas 78712

UNIVERSITY OF WASHINGTON
Seattle, Washington

COLLEGE OF ENGINEERING. There are a number of laboratories throughout the College of Engineering which are used to support teaching and research in Ocean Engineering. A large Chemical Engineering Laboratory with special facilities such as a 20-foot glass distillation column, a 20-foot absorption column, and a fluid (air and water) loop for research and calibration is available. A hydraulics laboratory housed in a separate facility, a sanitation laboratory, and a structures laboratory are available in Civil Engineering. Electrical Engineering has the acoustics laboratory, the electronics and control systems laboratory, and the energy conversion laboratory. Mechanical Engineering has heat transfer and thermodynamics, experimental stress analysis, and material processing laboratory, and a vibrations and acoustics laboratory. A ceramics laboratory, a materials property laboratory and a minerals processing laboratory are available through Mining, Metallurgy and Ceramics. Nuclear Engineering has a separate teaching and research nuclear reactor (100 KW argonaut type) housed in a separate facility. Outstanding collections of books and periodicals of interest to engineers as well as a research computer laboratory round out the facility.

Students may **specialize in Ocean Engineering at the B.S., M.S. or Ph.D. level** by enrolling through any of the engineering departments in the College of Engineering. Theses at the M.S. and Ph.D. level are required in the field of Ocean Engineering. The addition and substitution of courses in oceanography, fisheries, atmospheric sciences, economics, etc., into the engineering program are presently arranged on an individual basis. Degrees are granted through the College of Engineering with a major in the appropriate engineering field.

The Division of Marine Resources acts as coordinator of the work being carried out in the marine-related sciences between the many Departments and Colleges of the University which are active in this field. These include Atmospheric Sciences, Botany, Chemical Engineering, Civil Engineering, Economics, Fisheries, Food Science, Forestry, Geography, Geophysics, International Business, Law, Mechanical Engineering, Oceanography, and Zoology.

The following courses are offered in conjunction with the degree programs (credits are in quarter hours). Basic engineering courses required for studies in Ocean Engineering from all the branches of engineering have not been listed. These may be obtained by reference to the University of Washington general catalog.

Civil Engineering			
341	Hydraulics	W	3
350	Sanitary Engineering	F, Sp	3
457	Instrumentation for Air and Water Analysis	W	3
522	Transportation Systems	F	3
523	Transportation Terminals	W	3
542, 543	Hydrodynamics I and II	F, W; Sp	3, 3
544	Coastal Hydraulics	Sp	3
550, 551	Sanitary Engineering Unit Operation I and II	W, W	3, 3
553	Advanced Sanitary Biology	W	3
556	Bioengineering Aspects of Waste Treatment	Sp	3
557	Water and Waste Water Treatment	Sp	3
558	Water Quality Management	W	3
559	Water Resource Management	F	3
Mechanical Engineering			
490, 491, 492	Naval Architecture	F, W, Sp	3, 3, 3

The University also offers undergraduate and graduate programs in marine sciences and fisheries which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Civil Engineering

Carlson, Dale A., Ph.D., Professor of Civil Engineering
Chenoweth, Harry H., M.S., Associate Professor of Civil Engineering
Christman, Russell F., Ph.D., Assistant Professor of Chemistry

Department of Civil Engineering—*Continued*

Ekse, Martin I., M.S., Professor of Civil Engineering
Hennes, Robert G., M.S., Professor and Chairman Civil Engineering
Mar, Brian W., Ph.D., Research Associate Professor of Civil Engineering
Nece, Ronald E., Sc.D., Professor of Civil Engineering
Richey, Eugene P., Ph.D., Associate Professor of Civil Engineering
Sylvester, Robert O., S.M., Professor of Civil Engineering
Welch, Eugene B., Ph.D., Assistant Professor of Applied Biology

Department of Chemical Engineering

Gardner, Howard S., Sc.D., Professor of Chemical Engineering and of Pulp and Paper Technology

Mechanical Engineering

Bartlett, Francis G., M.S.E., Associate Professor of General Engineering
Browne, Oscar M., Jr., M.S., Lecturer in Mechanical Engineering

Note: Faculty members in the College of Engineering teaching basic engineering courses required in the Ocean Engineering program are not listed but may be obtained by reference to the University of Washington general catalog.

To obtain further information, address all inquiries directly to:

Dr. Stanley R. Murphy
Director, Division of Marine Resources
University of Washington
Seattle, Washington 98105

WEBB INSTITUTE OF NAVAL ARCHITECTURE
Glen Cove, New York

Specialized facilities include a model basin, 93' x 10' x 5', with wavemaker, flow channel, Marine Engineering Laboratory which includes operating components of commonly encountered marine machinery, steam and diesel and time-sharing computer facilities.

Webb Institute offers the following degrees:

1. **Bachelor of Science in Naval Architecture and Marine Engineering**
2. **Master of Science in Naval Architecture**

The following courses are offered in conjunction with the above degrees:

Practical Naval Architecture I	F
Practical Naval Architecture II	Sp
Ship Resistance and Propellers I	Sp
Ship Resistance and Propellers II	F
Theoretical Naval Architecture I	F
Theoretical Naval Architecture II	Sp
Theoretical Naval Architecture III	F
Ship Structures	Sp
Ship Design I & II	F, Sp
Marine Engineering I	Sp
Marine Engineering II	F
Marine Engineering III	F
Marine Engineering IV	Sp
Marine Engineering V	F
Marine Engineering VI	Sp
Fluid Mechanics II	Sp
Hydrodynamics II	Sp (of second year)
Advanced Structural Mechanics	F (of second year)
Advanced Structures I & II	Sp (of second and third years)

The instructional staff for the courses listed above consists of the following:

Curran, Thomas M., M.E., Professor of Naval Architecture
Lewis, Edward V., M.S., Research Professor of Naval Architecture
Nevitt, Cedric R., S.M., Professor of Naval Architecture
Holm, Jens T., M.S., Professor of Marine Engineering
Hamlin, Norman A., S.M., Research Professor of Naval Architecture
Ward, Lawrence W., D.Sc., Professor of Engineering
Maclean, Walter M., D.Eng., Professor of Engineering
Hoffman, Dan, B.Sc., Research Associate

To obtain further information, address all inquiries directly to:

W. A. Brockett, Rear Admiral, USN (Ret.)
President
Webb Institute of Naval Architecture
Glen Cove, New York 11542

OTHER INSTITUTIONS OFFERING COURSES IN OCEAN ENGINEERING

University of Massachusetts

CURRICULA FOR MARITIME OFFICERS

CALIFORNIA MARITIME ACADEMY
Vallejo, California

The Academy is situated on a 67-acre campus adjacent to the Carquinez Straits. A deep water pier provides berthing space for the training ship GOLDEN BEAR and encloses a boat basin for power, sailing, and rowing boats.

An engineering building, Dwyer Hall, completed in 1961, provides office space for the Marine Engineering Department and classroom and laboratory facilities for instruction in chemistry, physics, electricity, electronics, diesel engines, machine shop and welding and burning.

The Federal Maritime Administration has provided the academy with a modern 7,040 ton, twin screw, turbo-electric drive, 16-knot vessel for the purpose of conducting the annual sea training period of approximately three months. The training ship GOLDEN BEAR is operated entirely by the midshipmen under the supervision of the Academy's licensed officer-instructors. The GOLDEN BEAR provides a modern training vessel for the actual performance of deck and engineering skills at sea. The ship is fitted with classrooms, a machine shop and the most modern equipment, including steam and diesel powered auxiliaries as well as turbo-electric propulsion. Reading and recreation rooms provide the necessary facilities for off-duty activities.

The Bachelor of Science degree in Nautical Science or the Bachelor of Science degree in Marine Engineering is conferred upon Midshipmen successfully completing the Academy program of instruction and the U.S. Coast Guard license examination.

The following courses are offered by the Departments indicated in conjunction with the above degrees:

Department of Nautical Science

D-108	Navigation
D-110	Engineering Graphics
D-111	Seamanship
D-112	Rules of the Road
D-115–116	Marlinspike Seamanship
D-117–118	Boats
D-125–126	Ship's Operations
D-201–202	Navigation
D-205	Physics I (Mechanics)
D-206	Physics II (Electricity)
D-207	Ship Construction
D-208	Maritime Economics
D-210	Ship Stability
D-212	Rules of the Road
D-215–216	Applied Seamanship
D-222	Instruments and Navigational Aids
D-223	Communications
D-225–226	Ship's Operations
D-301–302	Navigation
D-303	Meteorology
D-304	Maritime Law
D-305	Radar
D-306	Marine Rules and Regulations
D-308	License Seminar
D-309–310	Cargo I and II
D-311	Seamanship
D-312	Rules of the Road
D-323	Communications
D-325–326	Ship's Operations

Department of Marine Engineering

E-107–108	Chemistry I
E-109	Engineering Graphics
E-110	Physics I
E-111	Steam Engineering I
E-112	Steam Engineering II
E-113	Maritime Economic History
E-115–116	Boats
E-118	Machine Shop Lab
E-120	Marine Machinery Laboratory I
E-208	Machine Shop Theory
E-201–202	Steam Engineering III-IV
E-203–204	D-C and A-C Electrical Engineering
E-205	Physics II
E-212	Thermodynamics
E-216	DC Electrical Laboratory
E-217	Machine Shop Lab
E-218	Marine Machinery Lab III
E-220	Arc and Gas Welding
E-221	Refrigeration and Air Conditioning
E-223	Marine Machinery Lab II
E-301–302	Steam Engineering V-VI
E-303–304	Diesel Engineering
E-305	Engineering Materials
E-306	Ship Construction and Damage Control
E-307	Automation Principles
E-308	Electronics
E-310	Nuclear Power
E-312	Engineering Administration
E-314	Labor Relations
E-315	Diesel Laboratory
E-316	Machinery Analysis Laboratory
E-317	AC Electrical Laboratory
E-318	License Seminar
E-319	Marine Machinery Lab IV
E-320	Marine Machinery Lab V

The instructional staff for the courses listed above consists of the following:

Department of Nautical Science

Aguilar, CDR William H., B.S., CMA, Masters License unlimited, USNR (Ret.), Master Mariner, Head of Department

Heron, CDR Richard D., B.S., CMA, CDR USNR, Federal License: chief mate, steam and motor vessels, ocean, unlimited.

Taylor, LCDR Lyle, B.S., CMA, Federal license: third mate, steam and motor vessels, ocean, unlimited.

Craig, LT Robert, B.S., CMA, Federal license: third mate, steam and motor vessels, ocean, unlimited.

Aschemeyer, LT Manfred H. K., B.S., CMA, Federal license: master, steam and motor vessels, ocean, unlimited.

Newton, LT Fred B., Jr., LCDR USN (Ret.), Federal license: master, steam and motor vessels, ocean, unlimited.

Wood, LT Philo, CDR USN (Ret.), A.B., Federal license: master, steam and motor vessels, ocean, unlimited.

Department of Marine Engineering

Bruhn, CDR Otto J., LT USNR, Federal license: chief engineer, steam vessels, ocean, unlimited, Head of Department.

Behm, LCDR Arthur S., Jr., B.S., CMA, LT USNR, Federal license: chief engineer, steam vessels, ocean, unlimited.

Beland, LT Thomas J., B.A., Federal license: second assistant engineer, steam vessels, ocean, unlimited.

Branin, LT Samuel W., B.A., LCDR USCG (Ret.), Federal license: chief engineer, steam vessels, ocean, unlimited.

LaBombard, LT Frank L., CHMACH W-4 USNR, Federal license: second assistant engineer, steam vessels, ocean, unlimited.

Thor, LT Howard A., Ph.D., LTJG, Federal license: first assistant engineer, steam, and third assistant engineer, motor vessels, ocean, unlimited.

Nilsen, LT Norman, B.S., third assistant engineer steam and motor, ocean, unlimited.

Barber, Mr. William, M.S.

To obtain further information, address all inquiries directly to:

Mr. Louis E. Kiger
Public Information Officer
California Maritime Academy
Box 1392
Vallejo, California 94590

MAINE MARITIME ACADEMY
Castine, Maine

Facilities include (1) the 10,000 ton steam training ship STATE OF MAINE, (2) the 85-foot training vessel PATHFINDER, (3) several yachts ranging in size from 50 feet to 27 feet, (4) several launches and work boats. The training vessels are equipped with all normal electronic navigation gear, such as radar, loran, fathometer, etc. The yachts and launches can be used for small parties and nearby activities. Castine is a deep-water harbor, accommodating ships of any size, and the Academy's wharves are adequate. The dock-side facilities include a machine shop, a forge and foundry, a rigging loft, an auxiliary steam plant, and a nuclear reactor.

The following degrees are offered:

1. **B.S. in Marine Science**
2. **B.S. in Marine Engineering**

The following courses are offered in conjunction with the above programs:

Nautical Science Department

102, 201, 202, 301, 302, 401, 402	Piloting and Celestial Navigation
201, 402	Marine Meteorology
201, 202, 302, 402	Seamanship
301, 302, 401, 402	Rules of the Nautical Road
402	Maritime Rules and Regulations

Marine Engineering Department

102	Basic Nuclear Engineering
202	Nuclear Power
301, 302	Nuclear Propulsion and Reactor Operation
201, 202, 402	Marine Boilers
401	Thermodynamics
401, 402	Refrigeration
302, 401, 402	Diesel Engines
302, 401, 402	Turbines

The instructional staff for the courses listed above consists of the following:

Nautical Science Department

Terry, Russel H., Master Mariner, Oceans, unlimited, Chairman, Professor of Navigation
McReel, William H., Chief Mate, Oceans, unlimited, Professor of Meteorology
Brown, Alfred A., Chief Mate, Oceans, unlimited, Associate Professor of Navigation
Hathaway, Louis S., Master Mariner, Oceans, unlimited, Instructor Nautical Science
Strautman, Robert E., Third Mate, Oceans, unlimited, Instructor Nautical Science

Engineering Department

Brown, Edward F., Chief Engineer, Steam, unlimited, Chairman, Professor of Marine Engineering
Creighton, Franklin W., Chief Engineer, Steam, unlimited, Instructor, Marine Engineering Steam, unlimited
Markley, John P., Chief Engineer, Steam, unlimited, Instructor, Marine Engineering
Marks, Roger A., Second Assistant Engineer, Steam, unlimited, Instructor, Marine Engineering
Robinson, Charles S. L., M.S., Associate Professor, Nuclear Propulsion
Spinazola, Eugene H., Second Assistant Engineer, Steam & Diesel, unlimited, Nuclear Test Engineer, Instructor, Nuclear Propulsion
Wiles, James F., Chief Engineer, Steam, and Motor, unlimited Instructor, Marine Engineering

To obtain further information, address all inquiries directly to:

Dr. A. S. Fairley, Academic Dean
Maine Maritime Academy

Contact for Admission Information:

Lt. David G. Buchanan, Director of Admissions
Maine Maritime Academy
Castine, Maine 04421

THE MARITIME COLLEGE OF THE STATE UNIVERSITY OF NEW YORK
Fort Schuyler, Bronx, New York

(For a complete description of the College's facilities, please refer to the College's listing in the **Marine Sciences** section of this publication.)

The students who successfully complete the courses required by this curriculum receive the degree of **Bachelor of Science** and, after passing the required U.S. Coast Guard examinations, a Federal license as Third Mate in the Merchant Marine. Registered as a general purpose degree, the Bachelor of Science degree for Marine Transportation majors satisfies all the requirements of the Court of Appeals for admission to law schools in New York State.

If acceptable in all respects, the graduate of this program can obtain a commission as Ensign in the U.S. Naval Reserve. The Maritime College has been fully accredited by the Middle States Association of Colleges and Secondary Schools since 1952.

Marine Transportation Department courses:

The Marine Transportation Department of the Maritime College offers courses in Nautical Science, Marine Navigation, Ocean Transportation, Maritime Law; and Economics–Principles, Geography, International Trade and Labor.

The course of study for students majoring in Marine Transportation includes the theoretical and practical education necessary to develop highly qualified licensed officers. It combines the humanities and sciences with nautical and marine transportation subjects to achieve a well-rounded collegiate program which will fully equip a young man to meet the present and future problems of life and the needs of the maritime industry, afloat and ashore. Theory and practice are integrated by relating the scholastic efforts of the academic year ashore to those of the S.S.T.P. aboard the college training ship during the summer months. (S.S.T.P.–Summer Sea Training Program.)

The Summer Sea Term (SST) is made up of two sessions of approximately equal duration. The third (sophomore) and second (junior) classmen are required to take one of the two assigned sessions in each of these periods. The first (senior) classmen are required to take both sessions in that one sea term. The summer voyages are required, credit bearing, staff supervised educational periods intended to insure necessary operational experiences for all cadets. In order to be graduated every student must successfully pass each of the three indicated summer periods on the college training vessel. The sea period grade is a report for a single course that is made up of several phases and requirements. Failure may result in repeating the period or disenrollment for inaptitude. Each succeeding period at sea will demand of the student the assumption of additional supervisory responsibilities and advanced operational knowledge. The first session starts the next day after the last day of scheduled final examinations of the spring term and ends about the middle of July. The second session starts the day after the arrival at Fort Schuyler of the training ship from the first session voyage, and ends on or about 1 September.

The objectives of the Summer Sea Training Term are accomplished by on-the-job training, by actual watch standing and ship work, and instruction through formal class periods which are designed to enhance the professional knowledge of the cadets. All phases of the program are conducted by experienced licensed officers and the cadets make use of the modern nautical equipment aboard the ship. Training aids are utilized when actual equipment is either not available or cannot be easily visualized.

Marine Transportation and Meteorology and Oceanography majors are rotated in a three-day cycle which includes one day each of watch, instruction, and ship maintenance. Within these phases each cadet receives training in the organization and management of a ship; ship maneuvering; navigation and meteorology; communications; and nautical rules of the road. All cadets are taught and exercised in abandon ship, fire and boat drills and ship safety, under simulated emergency conditions.

The Maritime College also offers undergraduate programs in marine science and ocean engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Marine Transportation

- **De Simone, Guy J., Master Mariner, MBA., Chairman and Professor of Marine Transportation**
- **Dutcher, Lester A., Master Mariner, MBA, Associate Professor of Marine Transportation**
- **Farrar, Richard A., Ph.D., Assistant Professor of Economics**
- **Frangul, Ramzi N., M.S., Lecturer in Labor Economics**
- **Gallo, Francis X., Chief Mate-Oceans, B.S., Instructor of Marine Transportation**
- **Hart, John C., J.D., Lecturer in Admiralty Law**
- **Millington, Herbert, Ph.D., Professor of Economics**
- **Mueller, Frank W., Graduate RCA Institute, Instructor of Marine Electronics**
- **Nelson, Harold, Master Mariner, B.S., Ship's Officer & Instructor**
- **Nolan, Gerard, Master Mariner; B.S., Executive Officer of Training Ship**
- **Parnham, Harold A., Master Mariner, M.A., Associate Professor of Marine Transportation**
- **Reynolds, Donald C., MBA, Lecturer in Economics**
- **Sembler, William, Master Mariner, MBA, Professor of Marine Transportation**
- **Van Wart, Donald W., Chief Mate (Unlimited), MBA, Associate Professor of Marine Transportation**

To obtain further information, address all inquiries directly to:

Mr. Guy J. DeSimone, Chairman
Department of Marine Transportation
State University of New York Maritime College
Fort Schuyler, New York 10465

TEXAS MARITIME ACADEMY
Galveston, Texas

A campus is maintained in Galveston, Texas. The TEXAS CLIPPER, a 15,000 ton vessel (supplied by the Maritime Administration), is maintained and used as a training ship which makes annual cruises. The Naval Science Department administers prescribed naval subjects within academic standards set by the Chief of Naval Personnel. Each cadet who completes the naval science courses and is otherwise qualified becomes eligible for, and may be granted, an inactive commission as Ensign, U.S. Naval Reserve, upon graduation. The objectives of the Naval Science Department are to provide the cadet with a well-rounded course in basic naval subjects; to develop an understanding of naval science and a knowledge of naval practice; and to develop, by precept and example, the psychology and technique of leadership.

The following degrees are offered:

1. **B.S. in Marine Engineering**
2. **B.S. in Marine Transportation**

The following courses are offered in conjunction with the above degrees:

Department of Marine Engineering

102	Orientation
200	Basic Operations
201	Marine Engineering Mechanics
203	Engineering Laboratory
204	Engineering Laboratory
300	Intermediate Operations
301	Fluid Mechanics and Heat Transfer
302	Engineering Laboratory
303	Marine Thermodynamics
304	Marine Thermodynamics
305	Strength of Materials
306	Marine Refrigeration and Air Conditioning
307	Electrical Circuits
308	Electrical Machinery
400	Advanced Operations
401	Nuclear Propulsion I
402	Diesel Engineering
403	Marine Steam and Gas Turbines
405	Steam Generators
406	Engineering Repairs
408	Nuclear Propulsion II
414	Ship Automation
415	Nuclear Propulsion III

Department of Marine Transportation and Nautical Science

101	Maritime Orientation
301	Ocean Transportation I
302	Marine Cargo Operations I
304	Ocean Transportation II
402	Ocean Transportation III
406	Marine Cargo Operations II

Department of Nautical Science

200	Basic Communications, Navigation, and Seamanship
201	Naval Architecture I
202	Naval Architecture II
203	Seamanship I
204	Terrestrial Navigation

Department of Nautical Science–*Continued*

300	Intermediate Communications, Navigation, and Seamanship
301	Seamanship II
302	Seamanship III
303	Celestial Navigation
304	Electronic Navigation
400	Advanced Communications, Navigation, and Seamanship
401	Seamanship IV
404	The Navigator

Department of Naval Science

208	Naval Orientation
209	Sea Power
210	Naval Weapons
309	Naval Machinery
310	Naval Operations
311	Navigation
410	Principles of Naval Leadership

The instructional staff for the courses listed above consists of the following:

Department of Marine Engineering

Tormollan, Francis C., M.S., Head, Marine Engineering Department
Dahm, Ralph A., M.S., Marine Engineering and Science
French, David, B.S., Lecturer, Marine Engineering
Moore, John A., B.S., Lecturer, Nuclear Engineering
San Martin, Joseph G., B.S.E., Naval Architecture and Marine Engineering
Crosby, Gary A., B.S., Marine Engineering

Department of Marine Transportation and Nautical Science

Philbrick, Alfred R., Jr., B.S., Head, Department of Marine Transportation and Nautical Science
Armstrong, Robert W., B.S., Marine Transportation and Nautical Science
McMullen, William T., B.S., Marine Transportation and Nautical Science
Fleming, William R., B.S., Seamanship, Education

To obtain further information, address all inquiries directly to:

Milton H. Abelow
Business Manager
Bldg. 311, Fort Crockett
Galveston, Texas 77550

UNITED STATES MERCHANT MARINE ACADEMY
Kings Point, New York

The Academy's 39 buildings and marine facilities occupy 65 acres on the north shore of Long Island overlooking Long Island Sound, and include academic buildings, resident halls, shops and laboratories. The Academy operates miscellaneous small training craft on Long Island Sound.

All students, deck and engineering, are required to complete the full four-year prescribed curriculum, which includes general education courses as well as professional courses. Upon satisfactory completion of the prescribed curriculum and after passing the U.S. Coast Guard examination for a license as Third Mate or Third Assistant Engineer, all graduates receive the same degree, **Bachelor of Science**, and a commission as an Ensign in the United States Naval Reserve.

Two professional curricula are offered. The Department of Nautical Science offers a program for the preparation of deck officers, and the Department of Marine Engineering offers a program for the preparation of engineering officers. An experimental program, offered jointly by the two major departments, prepares midshipmen for "dual-licensing," that is, it provides midshipmen with training for service as both deck and engineering officers.

During the second year of studies, midshipmen are assigned to merchant ships for practical experience in the operation of ships and the development of the technical skills required of an officer. The general purpose of this period of sea duty is to familiarize midshipmen with the work done by ocean vessels and to indoctrinate them in the routines of ship's business as well as the duties performed afloat by officers and seamen.

Although the midshipman is expected to perform the prescribed studies on his own initiative, his progress in theoretical and practical work is checked at frequent intervals. Academy Training Representatives in New York, New Orleans and San Francisco assign midshipmen to different types of ships for varied experience, check and guide their progress, and maintain liaison between the Academy, steamship companies and the midshipmen. The Department of Shipboard Training coordinates and supervises the shipboard training of all midshipmen during their year at sea.

The following courses are offered in conjunction with the above programs:

Department of Nautical Science

D111	Elements of Nautical Science	2
D112	Elements of Nautical Science	1½
D101	Safety of Life at Sea	1½
D102	Safety of Life at Sea	2
D141	Navigation	2½
D142	Navigation	4
D443	Navigation	3
D444	Navigation	4½
D121	Seamanship	3
D122	Seamanship	3
D423	Seamanship	2½
D424	Seamanship	2½
D103	Safety of Life at Sea	2
D104	Safety of Life at Sea	2
D405	Safety of Life at Sea	2
D406	Safety of Life at Sea	2
D407	Safety of Life at Sea	2
D125	Seamanship Laboratory	2
D126	Seamanship Laboratory	1
D127	Seamanship Laboratory	1½
D428	Seamanship Laboratory	1
D108	Communications	1
D109	Communications	1
D131	Cargo	3

Department of Nautical Science–*Continued*

D432	Cargo	3
D433	Cargo	3
D451	Electronics	3
D452–3	Electronics	6
D455	Gyro Compass Principles	2
D261	Naval Architecture	3
D262	Naval Architecture	3
D163	Naval Architecture	3
D171	Naval Architecture	3
D172	Naval Architecture	3
D481	Meteorology	3½
D482	Astronomy	3
D483	Oceanography	3

Department of Engineering

E101	Engineering Graphics	1
E102	Engineering Graphics	1
E103	Engineering Graphics	1½
E104	Engineering Graphics	1
E105	Engineering Graphics	1½
E106	Engineering Graphics	1
E111	Basic Marine Engineering	3
E112	Basic Marine Engineering	2
E113	Elements of Marine Engineering	3½
E114	Elements of Marine Engineering	2½
E115	Elements of Marine Engineering	2½
E123–4	Marine Machinery Repair	¾
E121–3	Machine Shop	5
E233	Statics	3
E234	Dynamics	4
E235	Hydraulics	3½
E236	Strength of Materials	4½
E241	Thermodynamics	3
E242	Thermodynamics	3¾
E243	Thermodynamics	3¾
E451	Marine Engineering	3¾
E452	Marine Engineering	3¾
E453	Marine Engineering	5½
E461	Electrical Engineering (Circuit Theory)	3¾
E462	Electrical Engineering (Electrical Circuits and Machines)	3¾
E463	Electrical Engineering (Electrical Machinery and Control)	5½
E471	Internal Combustion Engines	2¾
E472	Internal Combustion Engines	3¾
E473	Marine Refrigeration and Air Conditioning	5½
E231	Introduction to Engineering Science	3
E232	Introduction to Engineering Science	3
E464	Automatic Control Systems	4½
E465	Electronics for Engineers	3
E454	Marine and Industrial Water Analysis	3
E437	Machine Design	4

The instructional staff for the courses listed above consists of the following:

- Department of Nautical Science
  - Hurder, Captain W. R., USMS (Marine License: Master), Professor and Head of Department
  - Fiore, Commander A. E., USMS; B.S. (Marine License: Chief Mate), Professor
  - Pearson, Commander L., USMS; M.S. (Marine License: Master), Associate Professor
  - LaDage, Lieutenant Commander J. H., USMS; B.A. (Marine License: Second Mate), Associate Professor
  - May, Lieutenant Commander R. B., USMS (Marine License: Second Mate), Associate Professor
  - Nazzaro, Lieutenant Commander P., USMS; M.A. (Marine License: Master), Associate Professor
  - O'Hara, Lieutenant Commander W. J., USMS (Marine License: Third Mate), Associate Professor
  - Steiner, Lieutenant Commander G. N., USMS (Marine License: Third Mate), Associate Professor
  - Thompson, Lieutenant Commander O. E., USMS; B.S. (Marine License: Chief Mate), Associate Professor
  - Wichert, Lieutenant Commander W. A. A., USMS; B.S. (Marine License: Second Mate), Associate Professor
  - Webster, Lieutenant E. N., USMS; A.A. (Marine License: Second Mate), Assistant Professor
  - Caines, Lieutenant C. F., USMS; B.S. (Marine License: Master), Assistant Professor
  - Sopher, Lieutenant (junior grade) J., USMS; M.E.(E), M.B.A., Instructor
  - Cooney, Chief Warrant Officer E. T., USMS, Laboratory Instructor
  - Browder, Chief Warrant Officer R. A., USMS, Laboratory Instructor
- Department of Engineering
  - McCready, Captain L. S., USMS: M.M.E. (Marine License: First Engineer, Steam and Motor; Atomic Energy License: Sr. Reactor Operator; Professional Engineer (New York) License), Professor and Head of Department
  - Grom, Commander M. J., USMS; M.M.E. (Marine License: Chief Engineer; Professional Engineer (New York) License), Professor and Assistant Head of Department
  - Travis, Captain H. O., Jr., USMS; B.M.E. (Marine License: Chief Engineer; Professional Engineer New York) License), Professor
  - Carlson, Commander S. O., USMS; M.M.E. (Marine License: Second Engineer; Professional Engineer (New York) License), Professor
  - Hirschkowitz, Commander M. W., USMS; M.M.E. (Marine License; Chief Engineer; Atomic Energy License: Reactor Operator; Professional (New York) License), Professor
  - Hubert, Commander C. I., USMS; M.S.E.E. (Professional Engineer (New York) License), Professor
  - Sandberg, Commander C. W., USMS; B.S.M.E. (Marine License: First Engineer; Atomic Energy License; Reactor Operator), Professor
  - Drucker, Lieutenant J. H., USMS; M.E., M.S. (Marine License: First Engineer; Professional Engineer (New York and New Jersey) License), Associate Professor
  - Armstrong, Lieutenant Commander W. J., USMS (Marine License: First Engineer), Associate Professor
  - Barnes, Lieutenant Commander G. H., USMS; B.S. (Marine License: First Engineer), Associate Professor
  - Ferenczy, Lieutenant Commander E. D., USMS (Marine License: Chief Engineer), Associate Professor
  - Kirby, Lieutenant Commander H. M., USMS; M.A., Associate Professor
  - Schuler, Lieutenant Commander F. X., USMS; B.S. (Marine License: Second Engineer), Associate Professor

Department of Engineering—*Continued*

Wells, Lieutenant Commander R. B., USMS; B.S. (Marine License: Chief Engineer), Associate Professor

Kane, Lieutenant L. B., USMS; B.M.E. (Marine License: Third Officer), Assistant Professor

Kingsley, Lieutenant G. D., USMS (Marine License: Chief Engineer), Assistant Professor

McDonald, Lieutenant W. H., USMS; M.S., Assistant Professor

Panuska, Lieutenant R. C., USMS; A.B., Assistant Professor

Reynolds, Lieutenant F. X., USMS; B.S., B.S.M.E. (Marine License: Second Engineer; Professional Engineer (New York) License), Assistant Professor

Giaquinto, Lieutenant (junior grade) J. A., USMS, Instructor

Antell, Lieutenant (junior grade) J., USMS, Laboratory Instructor

Malinoski, Lieutenant (junior grade) L. A., USMS, Laboratory Instructor

Maroney, Lieutenant (junior grade) N. J., USMS (License: Journeyman Electrician), Laboratory Instructor

Newman, Lieutenant (junior grade) H. J., USMS (License: Certified Welder), Laboratory Instructor

Sferazo, Lieutenant (junior grade) L. J., USMS (License: Certified Welder), Laboratory Instructor

Smith, Lieutenant (junior grade) F. H., USMS, Laboratory Instructor

Department of Shipboard Training

Eisenberg, Captain R., USMS (Marine License: Master), Professor and Head of Department

Chicurel, Captain M. J., USMS; B.S. (Marine License: Master), Academy Training Representative, New York

O'Connell, Captain R. H., USMS; A.B., Academy Training Representative, San Francisco

Knutsen, Captain E. L., USMS; B.S. (Marine License: Master), Academy Training Representative, New Orleans

Boyle, Lieutenant Commander D. E., USMS; B.S. (Marine License: Master), Shipboard Training Assistant (Deck)

Chronowski, Lieutenant (junior grade) R. A., USMS; B.S. (Marine License: Second Engineer), Shipboard Training Assistant (Engine)

To obtain further information, address all inquiries directly to:

Assistant Dean
United States Merchant Marine Academy
Kings Point, New York 11024

CURRICULA IN FISHERIES

HUMBOLDT STATE COLLEGE
Arcata, California

The marine science programs at Humboldt State College offer instruction and opportunities for research in marine fisheries, oceanography, and the marine aspects of zoology, botany and ecology. Present facilities include saltwater aquaria, a water chemistry laboratory, ichthyology laboratories, and zoology and botany classrooms and laboratories. A 40-foot research vessel equipped with standard oceanographic and biological instrumentation is available. A marine sciences laboratory with a modern saltwater system is located at Trinidad, California.

The College offers the following degrees through the Division indicated:

Division of Natural Resources

1. **Bachelor of Science in Fisheries**
    a. General Education—Required and elective courses to insure cultural breadth in the humanities, social sciences and English and speech.
    b. Lower division requirements: Biol. 3, Bot. 1, Chem. 10A-10B, 11; Math 15A; Nat. Res. 2, 40, Zool. 1, Physics 15A-15B.
    c. Upper division requirements: Zool. 101, 112, Bot. 140 or 145, Fish. 110A-110B-110C, Fish. 120A-120B or Ocn. 100, Fish 130 or 135, Fish. 150, Fish. 160, Fish. 195, and Fish. 198.
    d. Approved electives: A total of 25 units.
    e. Free electives to bring total units for the B.S. degree to 192.
2. **Master of Science in Fisheries**
    a. Prerequisites: Satisfactory undergraduate preparation in fisheries or zoology.
    b. Required courses: Fisheries 260, 290, 295, and 298.
    c. Approved upper division or graduate electives in related fields to bring total units beyond the bachelor's degree to 45.

The following courses are offered in conjunction with the above programs (credits are in quarter hours):

Division of Natural Resources:

Fisheries Courses:

Upper Division Undergraduate Courses

100	Introduction to Fishery Biology	3
102	Field Course in Fishery Biology	3
110A	Ichthyology	4
110B	Ichthyology	3
110C	Ichthyology	3
126	Problems in Water Pollution Biology	3
135	Ecology of Marine Fishes	4
150	Introductory Fish Population Dynamics	3
160	Principles of Fishery Management	3
170	Fish Culture and Breeding	3
175	Commercial Fisheries	3
180	Techniques in Fishery Biology	3
184	Fisheries Instrumentation, Gear, and Methods	2
195	Field Problems in Fisheries	1–4
198	Senior Fisheries Seminar	1

Graduate Courses

240	Early Life History of Fishes	3
245	Economically Important Invertebrates	3
250	Advanced Fish Population Dynamics	3
260	Advanced Principles of Fisheries Management	4
290	Thesis	1–4
295	Research Problems in Fisheries	1–4
298	Graduate Fisheries Seminar	1

The College also offers undergraduate and graduate programs in marine sciences which are described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Division of Natural Resources

Allen, George H., Ph.D., Professor and Coordinator of Fisheries
Barnhart, Roger A., Ph.D., Adjunct Associate Professor and Unit Leader, California Cooperative Fishery Unit
Bryant, Charles F., Ph.D., Adjunct Assistant Professor and Assistant Unit Leader, California Cooperative Fishery Unit
Welsh, James P., Ph.D., Associate Professor of Fisheries

To obtain further information, address all inquiries directly to:

Dr. James A. Gast
Director, Marine Laboratory
Humboldt State College
Arcata, California 95521

UNIVERSITY OF NORTH DAKOTA
Grand Forks, North Dakota

On the main campus in Grand Forks are four laboratories for fishery biology and limnology teaching and research, a marine aquarium facility, and oceanography teaching laboratory. Related facilities on the campus include the Computer Center containing an IBM 360 system and libraries containing the major fisheries biology, limnology and oceanography journals. The Chester Fritz Library is a Depository Library for Federal Government publications. The University Biological Station at Devils Lake has facilities for limnological and fishery research and boats and equipment for small lake studies.

The University offers the **B.S. degree in Fishery and Wildlife Management** through the Department of Biology.

The requirements for this degree are 125 credits which should include all of the following courses:

Biology 163–164	General Biology	8
Biology 332	General Ecology	4
Biology 336	Systematic Botany	4
Biology 341	General Physiology	4
Biology 350	Genetics	3
Biology 365	Comparative Anatomy of Vertebrates	4
Biology 403	Seminar	1
Biology 425	Ichthyology	3
Biology 431	Wildlife Management	4
Biology 433	Limnology	4
Biology 438	Fisheries Biology	4
Biology 480	Biometry	3
Chemistry 111–112	Principles of Inorganic and Analytical Chemistry	8
Chemistry 212	Organic Chemistry	5
Geology 101	General Geology	4
Geology 525	Weathering and Soils	4
Mathematics 105	Trigonometry	2
Mathematics 211	Analytical Geometry and Calculus	4
Physics 203	General Physics	4
Civil Engineering 213	General Surveying	3
Economics 101	Principles of Economics	3
Engineering Drawing 101	Engineering Graphics	2
English 209	Technical and Business Writing	2
Speech 101	Fundamentals of Public Speaking	3
Language 101, 102, 201	(any modern foreign language)	12

In addition, attendance for 1 session at a field station or field work with a conservation agency is required.

The University also offers a graduate program in marine sciences which is described in the Marine Science section of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Biology

Duerr, Frederick G., Ph.D., Associate Professor of Biology; Invertebrate Zoology and Physiology

Neel, Joe K., Ph.D., Professor of Biology, Director, Biological Station; Limnology

Owen, John B., Ph.D., Assistant Professor of Biology; Fisheries Biology

Department of Geology

Moore, Walter, Ph.D., Professor of Geology; Geophysics

To obtain further information, address all inquiries directly to:

Dr. Paul B. Kannowski, Chairman
Department of Biology
University of North Dakota
Grand Forks, North Dakota 58201

PENINSULA COLLEGE
Port Angeles, Washington

The fisheries building, completed in January, 1967, is an integrated unit comprised of one classroom, one lab-classroom, office for two instructors, an equipment room, museum, and workshop. A large covered area on one side furnishes shelter for boats, nets and other large equipment. Located on the campus is a 16' x 20' hatchery building capable of raising 250,000 fish to the fry stage. Two 15' circular cement ponds outside the building are used to hold fish until ready to plant. A small fishing boat, rehabilitated by the class, is also part of the equipment.

The degree of **Associate of Applied Arts (Fisheries Certificate)** is offered.

All students must receive passing grades in FISH 33, 34, 43, 44, 53 (Aquarium study), 54, 56, 72, 73, 74, 76 (Technical Report Writing), 80, 82 (Wildlife Management), 83, 90, 92, 93 (Fish and Game Regulations), 94 and GE91 (Surveying).

In addition to the above courses each student must complete one each of the fall, winter, and spring offerings of Fisheries Equipment–Hatchery Methods in any sequence, and have one year (or equivalent) of biological science. His college credits must total 90 credit hours.

The following courses are offered in conjunction with the above program. Those courses numbering 30-39 and 70-79 are offered in the fall quarter. Courses numbering 40-49 and 80-89 are offered in the winter quarter. Courses numbering 50-59 and 90-99 are offered in the spring quarter. (Credits are shown in quarter hours.)

Fish 33	Fish Identification	3
Fish 34	Commercial Fishing Methods	3
Fish 35	Fisheries Equipment	1
Fish 43	Life History of Fishes	3
Fish 44	Marine and Freshwater Environments	3
Fish 45	Fisheries Equipment	1
Fish 54	Fish Tagging	3
Fish 55	Fisheries Equipment	1
Fish 56	Oceanographic Research Methods	2
Fish 72	Fish Diseases	3
Fish 73	Fish Farming	2
Fish 74	Marine Mammals	1
Fish 75	Fisheries Equipment	2
Fish 80	Fisheries Statistics	3
Fish 83	Fish Farming	2
Fish 85	Fisheries Equipment	2
Fish 90	Fisheries Statistics	3
Fish 91	Aquatic Insects	3
Fish 92	Marine Invertebrates	3
Fish 94	Water Pollution	3
Fish 95	Fisheries Equipment	2

The instructional staff for the courses listed above consists of the following:

Fisheries Department

Mausolf, Robert G., B.S., Chairman, Fisheries Department, and Instructor
Well, Donald R., B.S., Fisheries Instructor
Grinols, Richard B., M.S., Fisheries Instructor

To obtain further information, address all inquiries directly to:

Registrar
Peninsula College
Port Angeles, Washington 98362

UNIVERSITY OF RHODE ISLAND
Kingston, Rhode Island
(Department of Fisheries & Marine Technology only)

The Department operates facilities both on and off the main campus at Kingston. Main operations are conducted from Wickford on Narragansett Bay where the training vessels are berthed. The facilities contain practical laboratories for training in Seamanship, Fishing Gear, Navigation, Electronic Aids (to navigation and fisheries), Engineering, and Electrical Technology. Two training vessels are available; the 47-foot GAIL ANN, specifically converted for fisheries training and completely equipped, with a Decca Navigator and Sonar, and capable of working all common fishing methods; and a 21-foot Romany Fisherman for in-shore training.

The Department offers the degree of **Associate in Science (Commercial Fisheries).** In order to obtain the degree, all students are required to complete 74 credits over a two-year period–45 in Fisheries and Marine Technology, 14 in General Education, and 15 in Business and Economics–and must satisfactorily complete eight weeks of field training aboard commercial fishing vessels between the first and second school years.

The following courses are offered by the Department in conjunction with the above program:

1	Seamanship	F	3
2	Fishing Gear I	F	5
3	Fishing Gear II	F	3
4	Fishing Gear III	Sp	4
5	Marine Technology I	Sp	4
6	Marine Technology II	F	4
7	Navigation I	Sp	4
8	Navigation II	F	3
9	Biology and Conservation	Sp	3
10	Vessel and Construction Appraisal	F	3
11	Fishery Technology	F	3
12	Fisheries Hydrography	Sp	4
20	Fisheries Problems	Sp	1

The University also offers graduate programs in marine science and ocean engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Sainsbury, John C., Ph.D., Chairman and Associate Professor of Fisheries and Marine Technology

McCauley, James A., B.S., Assistant Professor of Fisheries and Marine Technology

Mead, Thomas L., Ph.D., Associate Professor of Fisheries and Marine Technology

Motte, Geoffrey A., Master Mariner, Assistant Professor of Fisheries and Marine Technology

Thomson, David B., Full Fishing Skipper, Assistant Professor of Fisheries and Marine Technology

To obtain further information, address all inquiries directly to:

Dr. J. C. Sainsbury, Chairman
Department of Fisheries & Marine Technology
210 Woodward Hall
University of Rhode Island
Kingston, Rhode Island 02881

UNIVERSITY OF WASHINGTON
Seattle, Washington

COLLEGE OF FISHERIES. The College of Fisheries is located on the University of Washington campus in the Fisheries Center Building. The Center houses classrooms, laboratories and general facilities as well as several research organizations.

The College has a collection of over 300,000 cataloged specimens of fishes for research and teaching purposes. It also has an experimental fish hatchery which developed and maintains the salmon run which is the basis for both instruction and research in the life cycle of Pacific salmon. A recirculating salt water aquarium is maintained for the study of the physiology and behavior of fish. There is, in addition, an extensive library of computer programs for processing biological data, and access to a Burroughs B5500 and an IBM 7040-7094 direct couple system.

The College of Fisheries field station at Big Beef Creek on Hood Canal provides additional opportunities for class field studies and research in stream and estuarine ecology. The Food Science facilities include separate well-equipped laboratories for food microbiology, food biochemistry and food analysis. A unique feature is the cobalt 60 research irradiator. A 67-foot diesel powered boat, operated by the College, is capable of trawling to a depth of 1,000 fathoms and is equipped for other types of fishing as well as a wide variety of experimental work.

The following degrees are offered in the College of Fisheries:

1. **Bachelor of Science in Fisheries (College of Fisheries–Fisheries Biology).** A student may major in fishery science or fishery management and administration. To do this he must take courses in Introductory Biology or Zoology, General Chemistry, English, College Algebra, Elements of Statistical Methods and Fisheries 101, 240, 311, 401, 456 and 495. In addition he must complete the required courses for his selected option.

2. **Bachelor of Science (College of Fisheries–Fisheries Biology).** An elective curriculum is available for students desiring a Bachelor of Science with a major in fisheries. The student must complete 36 credits in fisheries and sufficient electives to meet the University graduation requirements (as generally outlined for the above degree). This degree is specifically intended for students desiring a strong minor (minimum of 30 credit hours) in a related field. The choice of electives is subject to approval by the College.

   Prospective students are invited to inquire about additional areas of emphasis in which undergraduate preparation may be made. Such areas include behavior, biometrics, economics and water pollution.

3. **Bachelor of Science (College of Fisheries–Food Science).** To obtain this degree in the food science program the student must complete the requirements for University graduation with at least ten hours in humanities and biological studies. Courses in biochemistry, chemistry, mathematics, physics, preventive medicine and Fisheries 380, 495 and Food Science 481, 482, 483, 484, 485, 487 and 498 are required.

4. **Master of Science (College of Fisheries).** Students must have a degree of bachelor of science in biological or physical science or fisheries or food science or the equivalent. At least one year of approved study with a completion of a research project and thesis leads to the Master's degree. A minimum of 45 upper division or graduate credits must be presented including 18 credits in Fisheries 700 or Food Science 700, six credits for Fisheries 520 or Food Science 521 and three additional credits in courses numbered 500 or above. Students must present a certificate of proficiency in one foreign language.

5. **Doctor of Philosophy (College of Fisheries).** Students must complete at least three years of graduate study including a dissertation. Credits earned for a Master's Degree may be applied toward the Doctor's degree. Students must present a certificate of proficiency in two foreign languages or in one foreign language with extended proficiency in translation.

The Division of Marine Resources acts as coordinator of the work being carried out in the marine-related sciences between the many Departments and Colleges of the University which are active in this field. These include Atmospheric Sciences, Botany, Chemical Engineering, Civil Engineering,

Economics, Fisheries, Food Science, Forestry, Geography, Geophysics, International Business, Law, Mechanical Engineering, Oceanography, and Zoology.

The following courses are offered in conjunction with the above programs (credits are in quarter hours).

Economics			
535	Economics of Natural Resources	Sp	
Fisheries			
101	Introduction to Fisheries Science	F	5
240	Applications of Digital Computers to Biological Problems	W	4
311	Biology of Fishes	F	3
314	Methods and Instruments for Fishery Investigations	F, W, Sp	1, Max 3
379	Fisheries of the World	F	3
401	The Comparative Anatomy and Classification of Fishes	F, Sp, Su	5
405	Economically Important Mollusca	F	5
406	Economically Important Crustacea	W	5
410	Zoogeography of Freshwater Fishes		3
425	Life History of Marine Fishes	W	5
451	Reproduction of Salmonoid Fishes	F	5
452	Nutrition and Care of Fishes	W	5
454	Communicable Diseases of Fishes	Sp	5
456	Principles of Management of Natural Resources	W	3
457	Principles of Management of Natural Resources	Sp	3
459	Aquatic Food Chains	W	5
460	Water Management and Pollution Studies	Sp	5
465	Problems in Fish Biology	Su	6
471	Principles of Aquatic Radioecology	F	3
472	Methods of Aquatic Radioecology	W	3
473	Radionuclides in the Aquatic Environments	Sp	3
495	Introduction to Fisheries and Food Science Literature	F, W, Sp	2, Max 4
499	Undergraduate Research	F, W, Sp, Su	1–3, Max 9
501	On-the-job Training (Max 3 for M.S., 9 for Ph.D.)	F, W, Sp	1–3
503	Systematic Ichthyology	W	5
504	Invertebrate Pathology	F	5
505	Research Techniques in Shellfish Biology	W	5
506	Shellfish Sanitation	Sp	5
507	Topics in Fish Ecology	F, W, Sp	1–5, Max 15
510	Fish Behavior	F	3
511	Fish Behavior Laboratory	F	2–3, Max 6
515	Fish Physiology	W	3
516	Fish Physiology Laboratory	W	2
520	Graduate Seminar	F, W, Sp	2, Max 6
530	Biological Problems in Water Pollution	W	3
531	Seminar in Water Pollution Problems	Sp	3
535	Metabolic Effects of Chemical Pollutants	Sp	4
540	Application of Digital Computers to Problems in Aquatic Ecology	W	3
545	Speciation	W	3

Fisheries–*Continued*			
556	Introduction to Quantitative Population Dynamics	F	5
557	Theoretical Models of Exploited Animal Populations	W	5
558	Estimation of Population Parameters	Sp	5
600	Research	F, W, Sp, Su	*
604	Research (Max 3 for M.S., Max 10 for Ph.D.)		*
700	Thesis		*
Food Science			
481	Introduction to Food Technology	Sp	5
482, 483	Food Analysis I, II	F, W	3, 3
484, 485	Principles of Food Processing I, II	F, W,	5, 5
486	Deteoriorative Processes in Foods	Sp	5
487	Food Analysis III	Sp	3
504	Principles of Technological Research in Food	F, W, Sp	3, Max 6
521	Graduate Seminar in Food Science	F, W, Sp	1, Max 6
Forestry			
450	Recreational Use of Wild Lands	W	3
457	Field Problems in Outdoor Recreation	W	3
463	Contemporary Problems in Forest Land Use	W	3
476	Pulp and Paper Technology	W	3
477	Pulp and Paper Laboratory	Sp	3
481	Pulp and Paper Unit Operations	Sp	4
488	Polymer Chemistry	Sp	3
551	Current Problems in Recreational Management of Wildlands	Sp	3

The University also offers undergraduate and graduate programs in marine science and ocean engineering which are described in the appropriate sections of this publication.

The instructional staff for the courses listed above consists of the following:

Department of Economics

Crutchfield, James A., Jr., Ph.D., Professor of Economics

College of Fisheries

Beasley, Thomas M., Ph.D., Research Associate Professor of Radiochemistry
Bell, Milo C., B.S., Professor of Hydrology and Fish Guidance
Bevan, Donald E., Ph.D., Professor and Associate Dean
Bonham, Kelshaw, Ph.D., Research Professor in Radiation Biology
Brown, George W., Ph.D., Associate Professor of Biological Fisheries
Burgner, Robert L., Ph.D., Professor and Director, Fisheries Research Institute
Chapman, Douglas G., Ph.D., Professor
Chew, Kenneth K., Ph.D., Associate Professor, Shellfish Biology
DeLacy, Allan C., Ph.D., Professor of Marine Fish Ecology and Biology
Donaldson, Lauren R., Ph.D., Professor of Fish Biology
Hagen, Donald W., Ph.D., Assistant Professor and Curator of Fishes
Held, Edward, Ph.D., Research Professor in Radioecology
Jones, G. Ivor, Ph.D., Acting Associate Professor in Food Science and Gear Technology
Katz, Max, Ph.D., Research Professor in Water Pollution
Liston, John, Ph.D., Professor of Microbiology
Matches, Jack, Ph.D., Research Associate Professor in Microbiology
Mathisen, Ole A., Ph.D., Professor of Freshwater Ecology
Paulik, Gerald J., Ph.D., Professor of Population Dynamics

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*The amount of credit is variable.

College of Fisheries–*Continued*

Olsen, Sigurd M., Research Assistant Professor
Pigott, George M., Ph.D., Associate Professor in Food Engineering
Riddle, Victor M., Ph.D., Assistant Professor of Food Chemistry
Rogers, Donald E., Ph.D., Research Assistant Professor
Rothschild, Brian J., Ph.D., Associate Professor of Quantitative Ecology
Royce, William R., Ph.D., Professor and Associate Dean
Saddler, James B., Ph.D., Research Assistant Professor in Fish Physiology
Salo, Ernest O., Ph.D., Professor of Estuary Problems
Seymour, Allyn H., Ph.D., Professor and Director–Laboratory of Radiation Ecology
Smith, Lynwood S., Ph.D., Associate Professor of Fish Physiology
Sparks, Albert K., Ph.D., Professor of Shellfish Biology
Stober, Quentin J., Ph.D., Research Assistant Professor in Fisheries
Taub, Frieda B., Ph.D., Research Associate Professor in Ecology
Thorslund, Todd W., Sc.D., Assistant Professor
Van Cleve, Richard, Ph.D., Professor and Dean
Welander, Arthur D., Ph.D., Professor of Fish Taxonomy
Whitney, Richard R., Ph.D., Associate Professor

College of Forest Resources

Allan, G. G., Ph.D., Associate Professor of Fiber Science
Dowdle, Barney, Ph.D., Associate Professor of Forest Economics
Gardner, Howard S. (see Chemical Engineering)
Sharpe, G. W., Ph.D., Professor of Forest Recreation

To obtain further information, address all inquiries directly to:

Dr. Stanley R. Murphy
Director, Division of Marine Resources
University of Washington
Seattle, Washington 98105

OTHER INSTITUTIONS OFFERING COURSES IN FISHERIES

University of Alaska
Cornell University
University of Hawaii
Louisiana State University (Baton Rouge)
University of Massachusetts
University of Miami
Northeastern University

CURRICULA FOR MARINE TECHNICIANS

ANNE ARUNDEL COMMUNITY COLLEGE

Arnold, Maryland

The college occupied its new campus in 1967. At this time no special facilities are directly related to the program. However, marine instrumentation and ocean mechanics laboratories are planned for completion in 1970. Electrical and electronic laboratories and a computing center are currently available and utilized. The RIDGLEY WARFIELD, a modern catamaran oceanographic vessel operated by the Chesapeake Bay Institute, is being utilized on a lease basis for eight days afloat instruction and experience.

The College offers the **Associate in Arts degree in Ocean Engineering Technology.**

For the degree the student is required to take 45 total hours in Ocean Engineering Technology and related fields. The courses listed are required. In addition the student must complete 21-23 hours in general studies. In his second year he is required to take 3-4 hours of electives which may be chosen from the physical or biological sciences or the technologies.

Marine Science Courses Offered

OET 111	Oceanography	3
OET 112	Ocean Technology	4
OET 211	Marine Instrumentation	4
OET 212	Ocean Mechanics	4

The instructional staff for the courses listed above consists of the following:

King, Richard D., M.A., Assistant Professor and Director of Ocean Engineering

To obtain further information, address all inquiries directly to:

Registrar
Anne Arundel Community College
Arnold, Maryland 21012

CAPE FEAR TECHNICAL INSTITUTE
Wilmington, North Carolina

Facilities at the CFTI consist of three well equipped laboratories for marine biology, chemistry, and physics and classroom area for instruction and demonstrations.

Operations at sea, in the Institute's own training ship, include practical seamanship, navigation, fishing operations, and necessary experiments, collection, and processing of the data in connection with marine biology and oceanography.

The Institute has recently acquired the 65-foot T-426 on a long-term loan basis for short one or two-day trips out of Wilmington as a teaching aid. However, from time to time the vessel will be used in research projects.

The School Ship ADVANCE II which has a length of 185 feet, a beam of 33 feet, and a draft of 11 feet, carries a twenty-six foot motor launch for oceanographic and hydrographic work and a Coast Guard approved whale boat for rescue training. The vessel's range is 2,500 miles at 15 knots. Accommodations for up to 70 students and instructors, in addition to the crew, are available. A small machine shop, pipe fitters shop, and electricians shop are also aboard. It is equipped with an Alden Facsimile capable of receiving weather and oceanographic information plus a program calculator.

Navigational equipment on the ship includes: 2 radar sets, 48 mile range; 3 PPI scopes; 4 Loran systems including A&C; 1 automatic direction finder; 1 portable direction finder; 2 marine radiotelephones; 4 radio receivers; 1 sub-signal sounding machine 200 fathoms maximum depth (300 fathoms white line recorder); 1 master gyro system with repeater peloruses.

Biological and fishing instruments and equipment used aboard the vessel include a number of trawls, seines, gill nets, plankton net, and dredges. Aboard ship, there is a biological laboratory for dissection, classification, and pickling of marine specimens; 2 brine tanks for freezing, chilling, and preservation of live specimens; a freezer for preservation of fish; and 2 double sectioned fish pens for icing of fish.

Oceanographic instruments and equipment on board the vessel include: 1 4 ton boom for heavy dredging; 2 BT winches, 600 feet cable each; 2 BT booms, adjustable; bathythermographs; acoustic current meters; current meters; oceanographic chemical laboratory for determination of salinity, oxygen, etc.; oceanographic sedimentation laboratory; separate office for processing of oceanographic data; 37-foot cabin cruiser with depth recorder for shallow water work; two 26-foot launches for inshore work; several small boats for inshore specimen collecting; and a biological laboratory with refrigeration facilities.

The Institute offers the **Associate in Applied Science** degree in **Marine Technology**.

The following courses are offered by the Marine Technology Department in conjunction with the AAS program:

101	Technical English
102	Technical English
103	Technical English
204	Technical English
101	Technical Math
102	Technical Math
103	Technical Math
101	Technical Physics
102	Technical Physics
103	Technical Physics
Marine Science 301	Navigation & Seamanship
Marine Science 302	Navigation & Seamanship
Marine Science 303	Navigation & Seamanship
Marine Science 304	Cartography
Marine Science 307	Oceanography
Marine Science 308	Oceanography

Marine Science 311	Fishing Operations
Marine Science 312	Fishing Operations
Mechanics 317	Shipfitting & Maintenance
Mechanics 318	Marine Auxiliary Equipment
PM 301	Internal Combustion Engines
PM 302	Marine Diesel Engines
Chem 301	Chemistry
Chem 306	Marine Chemistry
Biol 301	Marine Biology
Biol 302	Marine Biology
AHR 306	Marine Refrigeration
	Typing and Calculator Practice
	General Ship Maintenance

The instructional staff for the courses listed above consists of the following:

Jordan, Arthur W., Capt. School Ship ADVANCE II and Coordinator of Marine Technology Department, Instructor in Fishing Operations and Oceanography

Arseneault, Walter A., B.M.S., First Mate on School Ship, ADVANCE II and instructor in mathematics; Navigation and Seamanship, and Cartography

Gossen, Emmett J., Chief Engineer School Ship, ADVANCE II and Instructor in Internal Combustion Engines; Marine Diesel Engines; Marine Auxiliary Equipment, and Shipfitting and Maintenance

Sullivan, Brian T., B.S., Second Mate on School Ship, ADVANCE II

Williams, Robert H., First Engineer on School Ship, ADVANCE II and Instructor in Engines

Foss, Edward, Applied Oceanography

Goode, Robert, Marine Biology

Stanton, Michael, Fishing Gear Techniques

Sullivan, Robert, Mathematics

Doughty, Aftin, Licensed Instructor of Engineering

James, Richard, Licensed Instructor of Navigation

To obtain further information, address all inquiries directly to:

Capt. Arthur W. Jordan
Coordinator, Marine Technology Department
Cape Fear Technical Institute
411 North Front Street
Wilmington, North Carolina 28401

Mr. Clarence E. Dodgens
Director of Student Personnel
Cape Fear Technical Institute
411 North Front Street
Wilmington, North Carolina 28401

CLATSOP COMMUNITY COLLEGE
Astoria, Oregon

The College has complete laboratories for students of physics, chemistry, geology, botany, and zoology consisting of over 3,000 sq. ft. Modern shops for training of electronic technology provide 4,000 sq. ft.; precision machine work, 4,000 sq. ft.; welding, 5,000 sq. ft. Basic mechanics instruction areas are also available.

Clatsop College has its own 24-foot motor launch TRAINER I. On this, the students learn boat handling, seamanship, and pilotage. Additional shipboard activities include the making of plankton tows, Nansen casts, bottom sampling, etc., within the estuary and on the Columbia River.

The students are offered a minimum of 20 days a year aboard Oregon State University's vessels. The cruises are on the ocean for the purpose of scientific exploration and training in seamanship on an ocean-going vessel.

The Marine Technology courses are geared to training students in the field of scientific oceanographic exploration, and training as Laboratory Technicians both ashore and afloat. Through these courses they receive a thorough knowledge of boat handling, seamanship and maintenance of vessels through the 65-foot class.

The following degrees are offered:

1. **Associate Degree in Marine Technology**
2. **Associate Degree in Oceanographic Technician**
3. **Associate Degree in Marine Electronics**

The following courses are offered in conjunction with the above degrees:

3.662	General Oceanography I	4
3.664	General Oceanography II	4
3.666	General Oceanography III	4
3.408	Techniques in Oceanography I	4
3.410	Techniques in Oceanography II	4
3.416	Oceanography Field Problems I	4
3.412	Oceanography Instruments I	3
3.500	Seamanship I	4
3.502	Seamanship II	4
3.504	Seamanship III	4
3.510	Electrical Equipment	2
3.512	Marine Biology I	4
3.514	Marine Biology II	4
	Commercial Fishing Techniques	4
3.524	Boat Maintenance and Repair	3
3.620	Navigation	

The instructional staff for the courses listed above consists of the following:

Elsbree, Jerrold S., Captain, Coordinator of Marine Technology Department, Master Mariner, Associate Degree in Marine Technology
Kujala, Norman, M.S.
Bainer, Philip L., M.S.
Samuel, Warren R., Electronics
Johnston, Donald, Electronics
Schultz, Alfred, Welding
Mabry, Boyd, Certified Vocational Instructor

To obtain further information, address all inquiries directly to:

Capt. J. S. Elsbree
Marine Technology
Clatsop Community College
16th & Jerome
Astoria, Oregon 97103

FULLERTON JUNIOR COLLEGE
Fullerton, California

Standard laboratory facilities and classrooms, ship time donated to us by local institutions and government agencies, and visits to regional industrial facilities provide instructional situations.

The Fullerton Junior College program in Oceanographic Technician training is designed to prepare entry-level technicians in marine oriented operations. The curriculum grants the **Associate in Arts degree**, enabling students to transfer to senior institutions to pursue an academic rather than vocational-technical goal.

Basic oceanographic science and associated subjects are provided in campus facilities. Special equipment, research situations, ship management and "hands on" training require off-campus opportunities, frequently donated facilities.

In-year and summer experiences with on-board or on-shore work programs provide the student with actual on-the-job conditions and credit for up to eight units.

Continuous evaluation of student performances and objectives provides opportunity for limited specialty training in the physical or biological techniques in the marine sciences.

The following courses are offered in conjunction with the Oceanographic Technician Program:

1	General Biology	F, Sp	5
25	Marine Biology	Sp	3
49ABC	Life Sciences Independent Study	F, Sp	1–1–1
30	Introduction to Ocean Science	F, Sp	3
32A	Oceanographic Materials and Instruments	F	3
32B	Oceanographic Materials and Instruments	Sp	3
33	Navigation–Drafting	Sp	4
54	Cooperative Oceanographic Technology		2–8
A	Trigonometry and Elementary Functions	F, Sp	5
1	Physical Geology	F, Sp	3
1L	Physical Geology Laboratory	F, Sp	1
3	Introduction to Chemistry	F, Sp	5
2A	College Physics	F, Sp	3
2B	College Physics	F, Sp	3
3A	College Physics Laboratory	F, Sp	1
3B	College Physics Laboratory	F, Sp	1
1AB	General Zoology	F–Sp	5–5
5AB	Principles of Biology	F–Sp	4–4
81A	Technical Mathematics	F, Sp	3
81B	Technical Mathematics	F, Sp	
10	Elementary Physics	F, Sp	4

The instructional staff for the courses listed above consists of the following:

Brown, Martin D., Chairman, Division of Life Sciences
Craig, Howard, Coordinator and Instructor
Leyman, Larry, Instructor

To obtain further information, address all inquiries directly to:

Howard Craig, Coordinator
Oceanographic Technicial Program
Fullerton Junior College
321 East Chapman Avenue
Fullerton, California 92634

363-212 O-69--18

HIGHLINE COMMUNITY COLLEGE
Midway, Washington

The facilities on the campus are located in the Science and Engineering buildings. Classrooms and laboratories contain modern equipment. The college also maintains laboratory and dock facilities on Puget Sound for underwater training. These facilities are equipped to provide training in all types and phases of diving.

The Award of **Certificate in Undersea Technology** is offered.

The following courses are offered in conjunction with the above award:

Diving		
71–73	Diving Fundamentals	5, 7, 7
74	Diving Applications	5
75	Marine Engines and Equipment	3
81–83	Advanced Diving	7, 7, 7
Engineering		
50	Blueprint Reading	3
60	Engineering Fundamentals	4
61–62	Materials and Processes of Industry	4, 4
82	Construction Material	3
121	Surveying	3
Electronics		
51	Basic Electronics	3
Math		
71	Technical Mathematics	3
72	Technical Mathematics	3
Oceanography		
100	Survey of Oceanography	5
Welding		
91–92	Welding	3, 2
P.E.	Life Saving	
English		
71–73	Communications	3, 3, 3

The instructional staff for the courses listed above consists of the following:

Elliott, Raymond S., Instructor, Welding
Hagen, Trond, B.S., Instructor, Civil Engineering
Powell, Roger B., M.A., Instructor, Engineering Technology
Sell, Phillip C., M.E.D., Department Chairman, Engineering Technology
Williams, Peter A., Instructor, Undersea Technology

Division of Natural Sciences

Chapman, D. Duane, Ph.D., Instructor, Oceanography
Livers, Joe J., Ph.D., Instructor, Mathematics
Neish, Gerald L., M.B.S., Instructor, Electronics

To obtain further information, address all inquiries directly to:

Mr. Peter Williams
Diving Instructor
Highline Community College
Midway, Washington 98031

Mr. F. Roger Smith
Assistant Dean, Occupational Programs
Highline Community College
Midway, Washington 98031

COLLEGE OF MARIN
Kentfield, California

As a part of its Marine Technology Program, the college has a marine laboratory at Bolinas, California. The station is equipped with a circulating sea water laboratory and student living quarters. Vast mudflats and rich intertidal reefs provide excellent locales for biological studies. Two Boston Whalers and a 32-foot diesel oceanographic ship provide facilities for making nearshore water and sediment measurements. Cooperative in-service training is provided by oceanographic organizations in the San Francisco Bay Area.

The curriculum is designed so that introductory background courses in marine sciences are given in the first year. The summer at the marine station provides practical experiences. The second year involves specialized instruction in marine instrumentation and engineering courses. The graduate is certificated as a general marine technician and receives an **Associate of Science** Degree.

The student is required to take 48 total hours in the basic sciences and related fields. The courses required for the certificated program are marked by an asterisk (*). In addition the student must complete 13 hours in general studies. In his 4th semester he is required to take 6 hours of electives, and during his summer session he may elect two additional credits. The following courses are offered in Marine Technology:

First Year–Introductory foundation courses		
1st Semester		
*Biol 10	General Biology	3
*Chem 11	Elementary Chemistry	4
*Geol 1A	Physical Geology	4
*Math 50, 52, 53	Elementary Algebra	3
2nd Semester		
*Biol 20A	Marine Biology	3
*Geol 20	Oceanology	3
*	Computer Data Technology	3
*ET 70	Basic Electronics	3
Summer Session at the Bolinas Marine Station		
*Biol 21A	Natural History of Marine Organisms	3
Optional		
Biol 21B	Marine Ecology	2
Nat Hist 49	Research	1–3
Second Year–Specialized Physical Science Technician Training		
3rd Semester		
*Chem 71	Chemistry Instrumentation	4
*Phys 55	Elementary Physics	4
*ET 65A	Electronics Math	3
*Engr 51A	Geometric Drawing	2
4th Semester		
*Phys 50	Physics Instrumentation	2
*Phys 51	Nuclear Instrumentation	1
*Engr 22	Basic Engineering Graphics	2
MMT 59	Machine Tool Processes	2
*NS 50	Marine Technician Seminar	1
Electives		
Biol 51	General Microbiology	
Geol 56	Elementary Mineralogy	
Engr 10	Surveying	
Art 48A	Basic Photographic Techniques	

The instructional staff for the courses listed above consists of the following:

Chan, Gordon L., M.A., Director of Marine Technology Program
Baver, David D., M.S., Oceanology
Bezirjian, Onnig H., Ph.D., Chemistry Instrumentation
Bruff, Stephen C., M.A., Geology
Greenfield, Donald R., M.A., Machine and Metals
Hansen, Michael P., B.S., Computer Data Technology
Howe, William W., M.S., Engineering Survey–Graphics
Johnson, Thos. C., M.A., Marine Photography
Martin, Donald W., M.A., Physics Instrumentation
Miller, Kenneth J., M.S., Mineralogy
Molina, Alfonso, M.A., Marine Biology
Petersen, Robert, M.S., Physics Instrumentation
Ridge, Russell M., M.A., Biology
Staley, James C., M.S., Electronics

To obtain further information, address all inquiries directly to:

Mr. Gordon L. Chan
Director, Marine Technology
College of Marin
Kentfield, California 94904

SANTA BARBARA CITY COLLEGE
Santa Barbara, California

The College offers a two-year training program for Marine Diving Technicians. The program was implemented in September, 1968, utilizing standard Physics, Geology, and improvised Marine Biology laboratories in addition to regular classrooms, welding shop and electronics laboratory. Basic Diving classes were conducted in a city-owned swimming pool with ocean dives from adjacent beach area and from A.C. Electronics research vessel SWAN. Advanced Diving classes will begin in the Spring of 1969 in special fiberglas tanks now being installed in an industrial facility rented by the College. Advanced ocean dives as well as practical experiments in Biological and Physical Oceanography will continue to be conducted from the SWAN. A complete machine shop facility is in the process of being established and will be available when required in September 1969. A new Life Science Building is now under construction. This building includes adequate laboratory facilities for Marine Biology, Biological Oceanography and Physical Oceanography.

The degree of **A.S. in Marine Technology** is offered by the Vocational-Technical Division. All students are required to complete a two-unit course in Hygiene and a three-unit course in American Institutions in addition to satisfactory completion of all course work listed below. Students must maintain a minimum grade point average of 2.0 ("C") in all courses in order to be eligible for the Associate in Science degree.

Courses used to make up the program for Marine Diving Technicians are offered by the following Divisions:

Life Science
Physical Science
Social Science
Business
Fine Arts
Vocational-Technical

The following courses are offered in conjunction with the above program:

English 18	Technical Report Writing		3
Speech 5	Business Speech		3
Biology 5	Marine Biology	F, Sp	3
Biology 11	Biological Oceanography	Sp	4
Geology 11	Physical Oceanography	F	4
Physics 11–12	Technical Physics	F, Sp	8
Economics 11	Marine Law and Economics	Sp	3
Electronics 11	Applications in Electronics	Sp	3
Electronics 41–42	Technical Mathematics		6
Marine Tech. 1	Introduction to Marine Technology	F	4
Marine Tech. 2	Basic Diving (SCUBA and HOOKAH)	F	3
Marine Tech. 3	Advanced Diving	Sp	3
Marine Tech. 4	Fundamentals of Marine Engines and Compressors	Sp	3
Marine Tech. 5	Underwater Construction	F	3
Marine Tech. 6	Underwater Operations	Sp	3
Marine Tech. 7	Diver Tending	Sp	3
Marine Tech. 11	Summer Work Experience	Su	1–8
Machine Shop 11	Machine Shop Operations	F	3
Welding 1–2	Oxy-Acetylene and Arc Welding	F, Sp	4

The instructional staff for the courses listed above consists of the following:

Life Science Division

Profant, Robert J., Ph.D., Chairman and Professor of Biology
Jorgensen, William C., M.A.

Physical Science Division

Gray, Robert S., Ph.D., Instructor of Geology

Schuler, Frederic C., Ph.D., Instructor of Physics

Business Division

Halloran, Jack R., M. Ed., Assistant Professor of Business

Fine Arts Division

Hale, Helen G. (Mrs.), M.A., Instructor of English and Speech

Vocational-Technical Division

Foxx, James E., M. Ed., Assistant Dean, Instruction, Vocational-Technical; Chairman of Vocational Technical Division

Parker, Jim G., A.A., Instructor of Marine Diving Technology

Parks, H. Ramsey, A.A., Instructor of Marine Diving Technology; College Diving Officer

To obtain further information, address all inquiries directly to:

James E. Foxx
Assistant Dean, Instruction, Vocational-Technical
Santa Barbara City College
721 Cliff Drive
Santa Barbara, California 93105

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SUFFOLK COUNTY COMMUNITY COLLEGE
Selden, L. I., New York

In addition to normal chemistry and biology laboratories, the following are used in teaching Marine Technology: a Sea Skiff 29-foot Cruiser, a Boston Whaler, a Special Marine Laboratory equipped with modern equipment, a 50 acre marine study area with two buildings, and the use of a Campus Computer Center.

The fundamental goal of the program is to provide qualified high school graduates with two years of coordinated technical and general education courses at the college level in order to enable them to function as technicians in marine and allied industries. A graduate of this program receives an **Associate in Applied Science Degree**, and is prepared to assume the duties of a marine technician.

The following courses are offered in conjunction with the above program:

MR 11	Commercial Fishing Techniques	2
MR 22	Navigation	3
MR 25	Elements of Oceanography	4
MR 30	Marine Ichthyology	3
MR 35	Applied Microbiology	3
MR 40	Commercial Marine Products	3
MR 45	Elements of Marine Ecology	4
MR 50	Shellfish	4
CH 25–26	Marine Technology Chemistry I and II	4–4
BY 33–34	Modern Biology I and II	4–4
DP 55	Computer Programming–FORTRAN IV	3

The following courses are offered for other students:

MB 21	Marine Biology
OC 15	Introduction to Oceanography

The instructional staff for the courses listed above consists of the following:

Black, John A., B.A., Instructor
Hardy, C. Douglas, M.S.T., Assistant Professor
Kirchner, Carl, Ph.D., Professor
Sherrill, Edwin L., A.A., Technical Assistant
Smith, Walter L., M.S., Professor, Head of Department of Marine Science and Technology
White, Harry H, Technical Assistant

To obtain further information, address all inquiries directly to:

Walter L. Smith, Professor
Head of the Department of
Marine Science & Technology
Suffolk County Community College
Selden, Long Island, New York 11784

TEXAS A&M UNIVERSITY, JAMES CONNALLY TECHNICAL INSTITUTE
Waco, Texas

and

TEXAS A&M MARINE LABORATORY
Galveston, Texas

The facilities at Waco include:

1. James Connally Technical Institute has classroom and laboratory facilities for and currently offers accredited courses leading to an **Associates of Applied Science Degree in: Electronics Technology, Instrumentation Technology and Electro-Mechanical Technology.**
2. Other related vocational courses provide complete classroom and shop facilities for teaching welding and the maintenance of gasoline and diesel engines.
3. Classroom and laboratory facilities for support courses in physics, mathematics, communication skills, and chemistry are available.

Facilities at Galveston include:

1. Texas A&M Marine Laboratory (biology laboratories, marine shops, four classrooms).
2. R/V ALAMINOS–used part-time for training purposes.
3. Texas Maritime Academy (classrooms, navigation and radio equipment).
4. TEXAS CLIPPER (15,000 ton training ship–used for life boat launching, winch operations and static displays).

Students completing a one-year program will receive a certificate of completion.*

Courses in Marine Science are offered by the Ocean Technician Training Department at Marine Laboratory, Galveston, a subsidiary reporting to James Connally Technical Institute (part of the Texas A&M University System).

The following courses are offered in conjunction with the Institute's program:

Oceanographic Instrument Technician:

OT-100	Occupational Orientation (Oceanography)	2
ELT-175	Shop Project (Marine oriented)	1
PHY-120	Applied Physics I	4
ELT-180	Instruments and Measurements	4
ELT-185	Electronic Devices (Marine oriented)	4
PHY-121	Applied Physics II	3
INT-261	Measuring Principles I	5
INT-256	Calibration and Standardization	4
CEM-157	Hydraulics and Pneumatics	3
OT-102	Descriptive Oceanography	4
Biol. 131.51	Marine Organisms of Commerce	3
OT-105	Principles of Navigation	5
OT-106	Seamanship	3
OT-201	Oceanographic Instrumentation	5
OT-202	Navigation and Radio	3
OT-210	Oceanographic Instrumentation, Calibration and Maintenance	6
OT-211	Oceanographic Data Reduction	3

Deck and Fisheries Technician:

OT-100	Occupational Orientation	2
PHY-102	Applied Physics I	3
CEM-157	Hydraulics and Pneumatics	3

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*The A.S. in Oceanographic Instrument Technology and the A.S. in Deck and Fisheries Technology degrees are proposed to begin within the next two years and will be offered at Galveston.

Deck and Fisheries Technician—*Continued:*

CHT-122	Chemistry of Metals I	3
OT-102	Oceanography	4
Biol. 131.51	Marine Organisms of Commerce	3
OT-105	Principles of Navigation	5
OT-106	Seamanship	3
OT-201	Oceanographic Instrumentation	5
OT-202	Navigation and Radio	4
OT-203	Rope, Knots, Cable, Fishing Gear Selection and Maintenance	4
OT-205	Fishing Technology, Economics and Maritime Law	6

The instructional staff for the courses listed above consists of the following:

a. JCTI Staff Members
  Lovelace, Richard, B.A., Associate Professor, Instrumentation
  Solomon, Charles, B.A., Electronics, Associate Professor, Electronics
  Hurley, Steve, BBA

b. Galveston Staff Members
  Rowe, Henry A., M.A., Director, Ocean Technicial Training
  Hennigan, John E., Instructor, Oceanographic and Electronic Instrumentation

c. A&M Marine Laboratory
  Ray, Dr. Sammy M., Ph.D., Director, Marine Laboratory (part-time instructor in marine biology in this program)

d. Texas Maritime Academy (part-time instructors in navigation and seamanship)
  Philbrick, Alfred R., Jr., Master, Training Ship TEXAS CLIPPER, Head, Department of Marine Transportation Associate Professor
  Fleming, William R., Assistant Professor, Department of Marine Transportation, Commandant of Midshipmen (acting)
  Armstrong, Robert W., Assistant Professor, Department of Marine Transportation, Chief Officer, TEXAS CLIPPER
  McMullen, William T., Assistant Professor, Department of Marine Transportation, Navigator, TEXAS CLIPPER
  St. Cyr, Leon, Chief Master at Arms, TEXAS CLIPPER, Chief Boatswain's Mate, USN (Ret.)

e. Bureau of Commercial Fisheries (part-time instructors), Fishing Technology, Gear Selection and Maintenance, Rigging, Knots
  Harrington, David L., B.S., Marine Supervisor and Fishing Gear Research
  Gislason, Sigvatur

To obtain further information, address all inquirires directly to

Captain H. A. Rowe, Director
Ocean Technicial Training
Marine Laboratory
Texas A&M University
Building 311, Fort Crockett
Galveston, Texas 77550

APPENDIX A

Institutions Offering Limited Ocean-Oriented Courses

APPENDIX A

The following institutions offer less than fifteen semester hours or equivalent of ocean-oriented courses:

1. Allegheny College
   Dr. Jonathan E. Helmreich
   Dean of Instruction
   Meadville, Pennsylvania 16335

2. Ball State University
   Mr. Robert L. Carmin, Dean
   College of Sciences and Humanities
   Muncie, Indiana 47306

3. California State College, Dominguez Hills
   Dr. Robert B. Fischer, Dean
   School of Natural Sciences and Mathematics
   100 East Victoria Street
   Dominguez Hills, California 90247

4. Cerritos College
   Mr. Jules M. Crane, Jr.
   11110 East Alondra Boulevard
   Norwalk, California 90650

5. Florida Presbyterian College
   Mr. Irving G. Foster, Chairman
   Division of Mathematics and the Natural Sciences
   St. Petersburg, Florida 33733

6. Ohio Wesleyan University
   W. K. Patton
   Department of Zoology
   Delaware, Ohio 43015

7. Rensselaer Polytechnic Institute
   Professor Samuel Katz
   Department of Geology
   Troy, New York 12181

8. State University College
   Director of Graduate Studies
   Oneonta, New York 13820

9. Virginia Polytechnic Institute
   Mr. Byron N. Cooper, Head
   Department of Geological Sciences
   Blacksburg, Virginia 24061

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